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## **REVISED ON-SITE SUPPLEMENTAL INVESTIGATION WORK PLAN**

**NU-WEST INDUSTRIES CONDA PHOSPHATE OPERATIONS,  
SODA SPRINGS, IDAHO**

8/15/2012

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SODA SPRINGS, IDAHO

8/15/2012

## Client

Nu-West Industries Conda Phosphate Operations

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### CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: 

Name: James A. Cagle

Title: Senior Environmental Specialist

Date: August 15, 2012

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# 1 Introduction

This Revised On-Site Supplemental Investigation Work Plan, Nu-West Conda Phosphate Operations facility, Soda Springs, Idaho, addresses comments on the draft work plan provided by the U.S. Environmental Protection Agency (EPA) in its July 16, 2012 correspondence to Nu-West Industries, Inc. (Nu-West). The work activities included in this work plan, as specified by EPA, consist of soil sampling at the North and South Car Wash areas; a plan to delineate the vertical extent of contamination at locations of previous borings designated SB-24, SB-48, and SB-67 beyond the maximum depth sample previously obtained at each location; a plan to characterize the potential pathways of contaminant migration at and around the Dry Products Storage building; and an integrity survey of the underground portions of the process sewer line(s) used to transport fluids to the Process Sewer Lagoon.

This Work Plan was prepared in accordance with the requirements of the Administrative Order on Consent ("Consent Order") that Nu-West and EPA executed on June 23, 2009. The Work Plan details the scope of work and associated quality assurance methods for the specified work requirements and is intended to meet the objectives identified by EPA.

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## 2 Sampling of North and South Car Wash Areas

### 2.1 Sampling Plan

Sampling of the north and south car wash areas (Figure 2) includes (1) the collection of surface soil samples from the four corner points adjacent to and at a distance of approximately 2 feet from the exterior of the concrete sump, with samples obtained from increasing depth intervals to the bedrock surface or refusal per the June 29, 2010, Work Plan; (2) a surface sample location that is to the east of the concrete sump and at a mid-point between the sump and the next pair of railroad tracks, with samples obtained from increasing depth intervals until interference with any underground structures or refusal is reached per the June 29, 2010, Work Plan; (3) two additional sampling locations, of which one shall be located 10 feet north of location [2] and the other 10 feet south of location [2], with samples obtained from increasing depth intervals until interference with any underground structures or refusal is reached per the June 29, 2010, Work Plan.

#### 2.1.1 North Car Wash Sump Sampling Locations

Seven soil borings (SB-88 through SB-94) will be advanced around the North Car Wash Sump (Figure 2). The locations are subject to adjustment in the field as required by conditions such as underground piping and utilities. Borings SB-88 through SB-91 will be advanced near the four corners adjacent to the exterior of the concrete sump. Due to piping and tank infrastructure, and the presence of subsurface utilities, these borings will be advanced with a hand auger. Practical limitations of this equipment will limit the maximum depth interval in these four locations to approximately 5 feet below ground surface (bgs). Boring SB-92 will be advanced at a location approximately mid-way between the sump and the adjacent set of railroad tracks to the east. Borings SB-93 and SB-94 will be located approximately 10 feet north of SB-92 and approximately 10 feet south of SB-92, respectively. Borings SB-92 through SB-94 will be advanced with a Geoprobe® rig and soil samples will be collected per the 2010 Work Plan soil sampling protocol.

Should any adjustments in the field be necessary, EPA will be notified of the revised sampling locations within one day of the completion of sampling at the North Car Wash Sump locations, SB-88 through SB-94, for review and concurrence of the revised locations.

#### 2.1.2 South Car Wash Sump Sampling Locations

Seven soil borings (SB-95 through SB-101) will be advanced around the South Car Wash Sump (Figure 2). The locations are subject to adjustment in the field as required by conditions such as underground piping and utilities. Borings SB-95 through SB-98 will be advanced near the four corners adjacent to the exterior of the concrete sump. Due to piping and tank infrastructure, and the presence of subsurface utilities, these borings will be advanced with a hand auger. Practical limitations of this equipment will limit the maximum depth interval in these four locations to approximately 5 feet bgs. Boring SB-99 will be advanced at a location approximately mid-way between the sump and the adjacent set of railroad tracks to the east. Borings SB-100 and SB-101 will be located approximately 10 feet north of SB-99 and approximately 10 feet south of SB-99, respectively. Borings SB-99 through SB-101 will be advanced with a Geoprobe® rig and soil samples will be collected per the 2010 Work Plan soil sampling protocol.

Should any adjustments in the field be necessary, EPA will be notified of the revised sampling locations within one day of the completion of sampling at the South Car Wash Sump locations, SB-95 through SB-101, for review and concurrence of the revised locations.



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## 2.2 Soil Sampling Protocols

### 2.2.1 Sample Collection

Soil borings will be installed using direct-push (i.e., Geoprobe®) methods. Continuous soil cores will be taken from each boring beginning at the ground surface and extending to the top of groundwater table or the depth where refusal is encountered. Depending upon the drilling method utilized, soil cores may be up to 4 or 5 feet in length and will be retrieved in acetate liners. Samples will be collected for laboratory analysis from 0-1 foot bgs; 1-2 feet bgs; and 4-5 feet bgs; and every additional 5-foot depth until the water table is encountered or refusal occurs. Standard Operating Procedure (SOP) #10 specifies the procedures for soil sampling using split-spoon equipment with drilling rigs, and SOP #24 specifies the procedures for soil sampling using direct-push (i.e., Geoprobe®) equipment (Appendix A).

All soil sampling activities will be conducted in accordance with the project Quality Assurance Project Plan (QAPP) included in the final revised work plan (WSP, 2010). Sampling protocol details are included in the QAPP and SOPs (Appendix A) and are summarized below.

### 2.2.2 Field QA/QC Samples

Soil sampling will include the collection of blind field duplicates at a ratio of 1:10, and equipment blanks on a daily basis. The field quality assurance/quality control (QA/QC) samples will be collected in accordance with SOP #21 (Appendix A).

### 2.2.3 Equipment Decontamination

Decontamination of drilling, augering, or direct-push equipment will be performed between each boring location, and decontaminated sampling equipment will be used for the collection of each sample. Decontamination procedures are specified in SOPs #15 and #19. Decontamination will include the use of a phosphate-free detergent, such as Liquinox®.

### 2.2.4 Sample Container Requirements

Soil samples will be placed in new laboratory-supplied, clean glass sample containers. Sample containers and preservatives will be as specified by the laboratory, in accordance with SOP #2. Each sample container will be labeled with a unique label description that will include the sample identification number, date and time of sample collection, analyses to be performed, sampler's initials, and the project name and number.

Following collection, each sample will be placed in a cooler and chilled to approximately 4 degrees Celsius. Samples will be packaged and shipped according to procedures described below.

### 2.2.5 Sample Packaging and Shipping

The lid of each sample jar will be securely tightened and samples placed in re-sealable plastic bags. Samples will be placed into a sample cooler or other appropriate shipping vessel and packed carefully to minimize the potential for breakage or spilling by using packing material (e.g., bubble wrap). In no case will glass sample containers be permitted to touch each other inside the sample transportation container.

Ice in watertight re-sealable plastic bags will be placed on top of the samples and packing. If shipped by common carrier, the appropriate chain-of-custody (COC) forms will accompany the samples sealed in the shipping cooler in watertight packaging. The COC forms must be dry and legible upon receipt at the laboratory.



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After packing, the containers must be sealed and managed in accordance with the COC requirements described below. If being shipped by common carrier, an appropriate completed air bill or freight bill will be taped to the outside of the container.

## **2.2.6 Chain-of-Custody Procedures**

COC procedures consist of several levels of documentation, including the field logbook, the COC form, and custody seals. These documents serve as the record for tracking sample collection and transport. Once a sample is obtained, it must be maintained under COC procedures until it is in the custody of the analytical laboratory. The person collecting the sample is responsible for the custody of the sample until it is properly transferred or dispatched. WSP's standard COC forms or laboratory-supplied COC forms shall be used.

### **2.2.6.1 Field Log Book**

The field logbook serves as official documentation of sampling activities. Field logbooks will be constructed of bound, sequentially numbered, water-resistant notepaper, and records will be kept in waterproof ink. Field personnel shall make frequent detailed entries to provide an adequate record of activities conducted during each day onsite. SOP #1 provides additional details of required protocol for the field log book.

### **2.2.6.2 Chain-of-Custody Form**

A COC form will be filled out either simultaneously with the notations in the logbook or shortly after sample collection is completed for the day. The information required on the COC form includes the project name and number; sampler's name and signature; sample numbers; sample matrix; date and time of sample collection; quantity of sample containers; analyses required; and custody sequence.

If the samples are being shipped by common carrier, the COC form will include the carrier airbill number in lieu of a custody signature from a courier employee. In this event, the COC form will be packed in a cooler with the laboratory samples in a re-sealable plastic bag. One copy of the COC form will be retained by the sampler. The sender's copy of the air bill will be affixed to this copy of the COC form and will become a part of the COC documentation. The original COC form will remain with the samples during shipment. The receiving laboratory will be instructed to sign the COC form and return one copy with the analytical data package. The original COC form will remain with the samples until their ultimate disposal.

### **2.2.6.3 Custody Seals**

To complete custody procedures for shipping, each sample cooler or container will be sealed with custody seals that are to be signed and dated by the shipper. The custody seal is a label with adhesive backing that is sealed over the container latch or across the closure point. If broken during transit, the sample custody has been compromised, which indicates potential tampering during transit. If unbroken, the integrity of the samples is assumed to be maintained.

## **2.3 Soil Analytical Program**

### **2.3.1 Laboratory Analyses**

Laboratory analyses for conventional chemical parameters will be performed by Accutest Laboratories Southeast, located in Orlando, Florida. Accutest Laboratories participates in the National Environmental Laboratory Accreditation Program (NELAP) and is certified by the NELAP accrediting authority in Idaho. Radiological analyses

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will be performed by ALS Laboratory Group located in Fort Collins, Colorado (formerly Paragon Analytics). ALS Laboratory Group holds NELAP certification, several state certifications for radiochemistry, and is listed on Idaho Department of Environment Quality (IDEQ's) current list of laboratories certified for drinking water analysis.

Soil samples will be analyzed for the following parameters:

- aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, thallium, and vanadium by EPA SW-846 Method 6010B
- fluoride by EPA SW-846 Method 9056A
- pH using EPA SW-846 Method 9045
- total phosphorous by EPA Method 365.3
- total Kjeldahl nitrogen (TKN) by EPA Method 351.2
- nitrate by EPA SW-846 Method 9056A
- ammonia by EPA Method 350.1
- gross alpha and gross beta by EPA Method 900
- radium 226 and radium 228 by EPA Method 901.1

Tables 1 and 2 summarize the soil sample collection and analytical program. Table 1 indicates the boring number, anticipated sample depths and intervals, and the analyses to be performed. Analytical parameters, method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, and laboratory reporting requirements are presented in Table 2. Table 2 also provides EPA Regional Screening Levels (RSLs) and IDEQ Initial Default Target Levels (IDTLs) values for soil.

### 2.3.2 Data Analysis

The results will be evaluated and incorporated into the overall assessment of conditions across the Site. The soil analytical results will be compared to RSLs for industrial soil, residential soil, and protection of groundwater, as well as IDTLs. These screening levels are shown on Table 2.

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## 3 Vertical Groundwater Profiling and Characterization

### 3.1 Borehole Locations and Objectives

As requested by EPA, groundwater monitoring wells will be installed at the locations of previous borings SB-24, SB-67, and SB-48 to further delineate the vertical extent of potential contamination (Figure 2). The well locations that correspond to previous borings SB-24, SB-67, and SB-48 will be designated A-34, A-35, and A-36, respectively. At each location, multiple boreholes will be drilled and up to three monitoring wells will be installed. The monitoring wells are intended to evaluate the following zones: 1) the surficial sediment/basalt interface; 2) the first water-bearing zone within the basalt sequence and; 3) the second water-bearing zone within the basalt sequence. Procedures for drilling and well installation are discussed in the following sections.

### 3.2 Borehole Drilling Procedures

The following revised borehole drilling, geophysical logging, and monitoring well procedures are applicable to the A-35 through A-36 locations. For any conflict in procedures found elsewhere in the Work Plan for Additional Requirements, the procedures in this section shall apply.

Two drilling methods are included in the revised approach, (i) air rotary using a down-the-hole-hammer (DTHH) with simultaneous casing advancement (hereafter referred to as advanced casing air rotary) and (ii) air rotary without simultaneous casing advancement (hereafter referred to as direct air rotary).

#### 3.2.1 Soil-Bedrock Interface Evaluation

Up to two boreholes will be advanced in each of the three locations (A-34, A-35, and A-36) using minimum 8-inch-diameter advanced casing or direct air rotary drilling methods to assess water at the soil/basalt bedrock interface. The boreholes will be located approximately 20 feet apart and will be advanced sequentially, completing the evaluation and well or casing installation or borehole abandonment at the first location before moving to the second location. The boreholes will be advanced to seven (7) feet below the top of basalt bedrock, which is assumed to be between approximately 10 to 30 feet below ground surface (bgs); however, the actual depth to top of bedrock will be identified during drilling at each location. If advanced casing or driven casing air rotary drilling method is used to maintain an open borehole through the soil overburden, the casing will be removed from the borehole or retracted to at least three (3) feet above the soil-bedrock interface to prevent restricting groundwater flow into the borehole before monitoring for the appearance of groundwater.

Upon reaching the target depth, the drill string will be removed from the borehole and the total depth will be measured. If loose soil or rock has collapsed into the bottom of the borehole and prevents measurement of the water level, the borehole will be cleaned out using the drill bit. The process to clean out the borehole will be repeated as necessary, and any efforts to clean out the borehole and observations regarding the occurrence of groundwater will be documented, recording the timing of each cleaning cycle and the volume of water produced each cycle. Upon removal of the drill string from a clean borehole, a temporary 4-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing with a 10-foot-long 0.020-inch slotted screen will be installed to monitor for the appearance of groundwater for at least 45 minutes, recording the depth observed at 15 minute intervals while monitoring for the appearance of water.

If a water column of at least 0.75 feet (9 inches) is present in the temporary PVC casing after 45 minutes, a grab sample will be collected using either an inertial pump, peristaltic pump, or bottom-filling polyethylene bailer in accordance with WSP revised SOP 3 (Appendix A). The sample will be analyzed for field parameters including pH, conductivity, temperature, and turbidity using a multi-parameter water quality meter (e.g., Horiba U-52). Additional analyses will be conducted using Hach portable colorimeter (DR/890) and field test kits for nitrate (Hach method 8039), sulfate (Hach method 8051), and orthophosphate (Hach method 8114 or 8048). The Hach procedure

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descriptions for each method are included as Appendix B. The multi-parameter water quality meter will be calibrated daily for pH, conductivity, and turbidity in accordance with the manufacturer's recommendations. An accuracy check will be performed daily for the Hach test kits using the Standard Solution Method as described in the procedure descriptions (Appendix B). The calibration and accuracy check records will be documented. Spent field test kit reagent and tested groundwater samples will be managed as investigation-derived waste.

Following the grab sampling, an attempt will be made to purge the temporary PVC casing dry by removing the volume calculated to be present in the borehole observed after grab sampling. Groundwater recharge to the borehole following purging will be observed for another 45 minutes as described above.

If groundwater in the temporary PVC casing recharges to at least 0.75 feet of water or remains static during the purge and grab sampling, a monitoring well will be installed in the borehole and screened across the soil-bedrock interface from 3 feet above the top of bedrock to 7 feet below the top of bedrock. If the water level meets the 0.75-foot threshold prior to 45 minutes, the well installation will proceed.

If less than 0.75 feet of water is observed during the initial 45-minute observation period or if less than 0.75 feet of water recharges during the second 45-minute observation period, a soil-bedrock interface monitoring well will not be installed. The borehole will either be abandoned with hydrated bentonite chips or a conductor casing will be installed for the bedrock borehole drilling as described below.

Monitoring wells installed at the soil-bedrock interface will be constructed using 4-inch-diameter, flush-threaded Schedule 40 PVC casing and 0.020-inch slotted screen with a bottom end cap. The PVC casing will be fitted with a single centralizer at the bottom of the screened interval to ensure that the well is centered in the borehole. The annular space will be backfilled with a clean graded silica sand to create a filter pack extending a minimum of 2 feet above the top of the screen. If the screened interval is submerged, a surge block will be used to settle the filter pack before placement of the annular seal. Additional sand will be placed in the well annulus to compensate for any settling that occurred as a result of the surging process until the filter pack is stabilized at 2 feet above the screen top. A minimum 3-foot-thick bentonite seal will be placed on top of the filter pack (after completion of surging) and consist of bentonite chips or pellets hydrated in place. The remaining annular space will be sealed with a bentonite-cement slurry grout containing no more than 5 percent bentonite per Idaho Administrative Rules for well construction. The slurry grout will be placed in the borehole using a tremie pipe to approximately 3 feet bgs.

Lithologic and groundwater observations at the soil-bedrock interface, including the depth to the top of bedrock, depth to water measurements, grab sampling results, and well construction information will be communicated to EPA at the conclusion of each day during the soil-bedrock interface evaluation.

### 3.2.2 Bedrock Borehole Drilling and Vertical Groundwater Profiling

At each of the three locations, two boreholes will be installed to evaluate bedrock groundwater; one borehole with a monitoring well screened at the initial bedrock water-bearing zone and one borehole with a monitoring well screened in a deeper water-bearing zone which is at least 20 feet below the bottom of the screened interval for the shallow well. The bedrock boreholes will be initially constructed with a conductor casing installed to 10 feet below the top of bedrock to case off perched groundwater. The boreholes will be advanced using nominal 16-inch-diameter direct air rotary drilling methods for installation of the nominal 10-inch-diameter steel conductor casing, which will be grouted into place.

Within the bedrock boreholes, vertical groundwater profiling and borehole geophysical logging will be conducted, followed by monitoring well installation.

After the nominal 10-inch-diameter steel conductor casing has been installed to 10 feet below the top of bedrock to case off perched groundwater, further borehole drilling will utilize nominal 8-inch-diameter advanced casing air rotary methods. Observations during drilling will include lithology of cuttings, advancement rate, depth of first strike of groundwater, and rate of groundwater production during drilling. Once the borehole reaches the first saturated zone in the basalt, groundwater grab samples will be collected at 10-foot intervals to a depth of approximately 60 feet below first strike of groundwater. For the first (uppermost) 10-foot interval within the saturated zone, the

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borehole will be developed by injecting compressed air through the drill string to blow out the borehole and remove any water initially added during the drilling process. Once it is certain that any added water has been removed (i.e., the borehole is “making water”), the drill string will be removed and a volume of water equivalent to approximately three borehole volumes will be removed using an inertial pump, peristaltic pump, submersible pump, or bottom-filling stainless steel or polyethylene bailer. To facilitate water coming into the borehole, it may be necessary to retract the advanced casing several feet. For subsequent sampling intervals, the bottom 10 feet of the borehole will be sealed off by removing the drill string and retracting the advanced casing approximately 11 feet and deploying an inflatable packer assembly equipped with an electric submersible pump installed through the advanced casing. The packer will be inflated against the borehole wall below the bottom of the advanced casing. A pump will be used to extract three borehole volumes of water (e.g., for an 8-inch-diameter hole 10 feet deep, one borehole volume equals approximately 26 gallons). After development at each sampling interval the water level in the borehole will be observed for approximately 20 minutes, or until conditions are relatively stable (i.e., water levels are no longer rising).

Grab samples will be collected using an inertial pump, peristaltic pump, submersible pump, or bottom-filling polyethylene bailer in accordance with WSP revised SOP 3 (Appendix A). The sample will be analyzed for field parameters including pH, conductivity, temperature, and turbidity using a multi-parameter water quality meter (e.g., Horiba U-52). Additional analyses will be conducted using Hach portable colorimeter (DR/890) and field test kits for nitrate (Hach method 8039), sulfate (Hach method 8051), and orthophosphate (Hach method 8114 or 8048). The Hach procedures for each method to be followed are included as Appendix B. The multi-parameter water quality meter will be calibrated daily for pH, conductivity, and turbidity in accordance with the manufacturer's recommendations. An accuracy check will be performed daily for the Hach test kits using the Standard Solution Method as described in the procedure descriptions (Appendix B). The calibration and accuracy check records will be documented. Spent field test kit reagent and tested groundwater samples will be managed as investigation-derived waste.

Advancement of the deep borehole will continue to a total depth of approximately 60 feet below the first strike of groundwater, stopping in 10-foot increments for development and grab sampling using the procedure described above. In the event that no additional water bearing zones are identified within 60 feet of first strike of groundwater, the borehole will be advanced until a second water bearing zone is identified. Lithologic observations, the occurrence and relative yield of water-bearing zones, and the results of groundwater profiling will be communicated to EPA at the conclusion of each borehole during the drilling and vertical groundwater profiling.

### 3.2.3 Bedrock Borehole Geophysical Logging

In the deep bedrock boreholes, downhole geophysical logging will be conducted after the borehole is advanced to the target depth. Geophysical logging will include natural gamma, neutron porosity, and gamma-gamma-density logs run through the advanced casing. The drilling observations and geophysical logging results will be reviewed to assess the potential for borehole collapse and identify zones likely to collapse. Key criteria for likely collapse within the basalt sequence include identification of interflow zones greater than approximately 10 feet in thickness characterized by intensely weathered basalt or scoria cuttings, the presence of sedimentary cuttings that correlate to the depth of prominent deflections in the geophysical logs, or notable changes in the rate of groundwater production during drilling. If the boreholes encounter the bottom contact of the basalt sequence and the underlying sedimentary sequence, likelihood of collapse will be based on the lithology and total thickness of the sedimentary sequence encountered in the borehole.

If borehole collapse occurs or likely collapse zones are identified, the bottom of the advanced casing will be raised to a competent zone underlying the likely collapse zone, and an acoustic televiewer and caliper log will be acquired for the open portion of the borehole below the advanced casing. The casing will then be raised to the next competent zone, and additional acoustic televiewer and caliper log data will be collected in the newly exposed portion of the borehole. In this manner, a nearly continuous acoustic televiewer and caliper log will be collected even if portions of the borehole are prone to collapse, while minimizing the risk of losing a geophysical logging tool.

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The results of borehole geophysical logging will be communicated to EPA at the conclusion of logging at each borehole.

### 3.2.4 Bedrock Monitoring Well Installation and Development

The screened intervals for monitoring wells installed in bedrock boreholes will be determined in consultation with EPA and based on a review of data collected from the boreholes, including drilling observations, first strike and static water levels measured in the boreholes and nearby monitoring wells, the results of vertical groundwater profiling, and the results of geophysical logging. The screened interval for the shallow bedrock borehole will correspond to the first water-bearing zone. The screened interval for the deep bedrock borehole will correspond to the second water-bearing zone and be at least 20 feet below the bottom of the screened interval in the shallow bedrock borehole. As such, the shallow bedrock monitoring well may be dry during periods of lower groundwater elevations, but the deeper bedrock monitoring well will be screened in a perennially saturated water-bearing zone such that it yields water at all times. WSP requests that EPA respond within 24 hours regarding proposed screen intervals.

The monitoring wells will be constructed using 4-inch-diameter, flush-threaded Schedule 40 PVC casing and 0.020-inch slotted screen with a bottom end cap. The screen lengths will be 20 feet. The PVC casing will be fitted with centralizers every 20 feet to ensure that it remains plumbed and aligned in the borehole during installation. The annular space will be backfilled with a clean graded silica sand filter pack installed via a tremie pipe to a minimum of 2 feet above the top of the screen. A surge block will be used to settle the filter pack before placement of the annular seal. Additional filter pack material will be placed in the annular space to compensate for settling of the pack material as a result of the surging process until pack is stabilized at 2 feet above the screen top. A minimum 3-foot-thick bentonite seal will be placed on top of the sand pack (after completion of surging) and consist of either bentonite chips or pellets or a bentonite slurry installed via tremie pipe, depending on the height of the water column above the screened interval and the depth bgs. The remaining annular space will be sealed with a bentonite-cement slurry grout containing no more than 5 percent bentonite per Idaho Administrative Rules for well construction. The slurry grout will be placed in the borehole using a tremie pipe to approximately 3 feet bgs.

The groundwater monitoring wells will be developed consistent with the requirements in EPA's Monitoring Well Development Guidelines for Superfund Project Managers dated April 1992. Groundwater monitoring wells will be developed no sooner than 24 hours after the placement of the bentonite-cement slurry grout seal. Well development will utilize a submersible pump and surge block, if necessary, to purge groundwater, until the development water is relatively free of suspended sediment and turbidity stabilizes to 20 nephelometric turbidity units (NTUs). If turbidity does not attain 20 NTUs, Nu-West will inform EPA and discuss next steps. During development, temperature, pH, specific conductance, and turbidity will be monitored using a multi-parameter water quality meter, and drawdown will be monitored using an electronic water-level meter. Submersible pumps will be decontaminated before each use.

The locations and elevations of the monitoring wells will be surveyed by an Idaho-licensed professional surveyor. For each monitoring well, the top of PVC casing and ground surface will be surveyed relative to the Idaho East Zone State Plane Coordinate System (North American Datum of 1983 [NAD83]) and the North American Vertical Datum of 1988 (NAVD88). Horizontal locations will be surveyed to the nearest 0.1 foot and vertical locations to the nearest 0.01 foot.

### 3.2.5 Monitoring Well Groundwater Sampling

The new wells will be sampled a minimum of 2 weeks after installation and development. If possible, the sampling will be conducted in conjunction with a semi-annual monitoring event. Low-flow purging and sampling techniques will be used in accordance with WSP's revised SOP 3 and EPA low-flow sampling guidance (EPA 1996). Before initiating the sampling activities, each well will be uncapped and allowed to stand for a minimum of 15 minutes while the water level in the well equilibrates with the atmospheric pressure. The depth to groundwater (to the



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nearest 0.01 foot) will be measured from the reference point on the north side of the inner well casing using an electronic water level meter.

Well purging will be conducted using a submersible or bladder pump capable of flow rates between 0.1 and 0.5 liter per minute. During purging, temperature, pH, specific conductance, dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP) will be monitored using a multi-parameter water-quality meter equipped with a flow-through cell (e.g., Horiba U-52), and drawdown will be monitored using an electronic water-level meter. Field parameters, including the water level in the well, will be recorded every 3 to 5 minutes until the parameters have stabilized with the two preceding measurements ( $\pm 10$  percent for temperature, turbidity, and DO;  $\pm 10$  mV for ORP;  $\pm 0.1$  unit for pH;  $\pm 3$  percent for specific conductance; and  $\pm 0.3$  foot for drawdown). Final turbidity readings should be less than 20 NTUs. If the turbidity criterion of less than 20 NTUs cannot be met, then the turbidity must be within  $\pm 5$  NTUs or 10 percent, whichever is greater, for three consecutive measurements before sample collection. After these parameters have stabilized, groundwater samples will be collected for laboratory analysis of the parameters listed in the Analytical Program described below and summarized in Tables 1 and 2.

Due to the potential for stagnant water in the soil-bedrock interface monitoring wells, groundwater sampling at these locations will utilize a three well volume purge prior to sampling. Water will be withdrawn using technology appropriate for slow-recovering wells, such as an inertial pump, peristaltic pump, or bottom-filling polyethylene bailer. If a monitoring well is purged dry during the removal of three well volumes, the well will be allowed to recharge for 24 hours, after which a grab sample will be collected for laboratory analysis. If insufficient water has entered the well for the full suite of analytes after 24 hours, bottle sets will be filled sequentially in the order specified in the Analytical Program described below.

All purge water generated during the monitoring well sampling activities will be contained in either Department of Transportation (DOT)-compliant 55-gallon steel drums or a small polyethylene tank, and managed at the CPO facility.

### 3.3 Groundwater Analytical Program

Tables 3 and 4 summarize the groundwater sample analytical program. Table 3 indicates sample number and the analyses to be performed. Analytical parameters and method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, and laboratory reporting requirements are presented in Table 4. The laboratories that will analyze the groundwater water samples are the same companies that will analyze soil samples as discussed in Section 2.3. In addition to the analyses listed in Table 4, field parameters to be monitored while sampling include pH, temperature, specific conductance, turbidity, DO, and ORP.

### 3.4 Data Analysis

The chemical analytical results for the groundwater samples will be compared to the Idaho Primary and Secondary Constituent Standards for groundwater (IDAPA 58.01.11) and EPA National Primary Drinking Water Maximum Contaminant Levels (40 Code of Federal Regulations [CFR] Part 141). The results will be evaluated and incorporated into the overall assessment of conditions across the Site.



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## 4 Dry Products Storage Area Evaluation

### 4.1 Objective

A photographic survey of the surface areas surrounding the Dry Products Storage Area will be conducted. This investigation will identify, photo document, and map all surface runoff areas, drains, ditches, drywells, sumps, and other surface conveyances that have the potential to transport runoff from the Dry Products Storage building.

### 4.2 Protocols

The investigation area and corresponding survey area will extend 100 feet radially outward from the Dry Products Storage building perimeter. All surface features will be mapped. The results report will include a narrative description of the conveyances, will identify the location of each conveyance on a map, and will include photo documentation that corresponds to mapped locations. The mapped locations will be noted on existing Nu-West Industries engineered drawings.

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## 5 Process Sewer Lagoon Pond Underground Conveyance Line Assessment

### 5.1 Objective

As directed by the EPA, an assessment of underground conveyance line(s) will be made to determine if there are any portions of the conveyance system that could be leaking. The inspection will concentrate on portions of pipelines that are buried and lack secondary containment.

### 5.2 Protocols

Nu-West will locate and identify all conveyance lines leading to the pond. These conveyance lines will be shown on a map in the final report. The lines will be flushed with raw water before using video equipment to view the inside of the pipe to check for breaches. Testing will be performed by remote video inspection and include a video record. The video inspection will be performed under the direction and in the presence of a qualified inspector. A procedure for the inspection of underground conveyance lines that connect to the process sewer lagoon and personnel qualifications is provided in Appendix C. Reports of the findings and recommendations will be documented in the inspection database (currently DMAPS). The report will include any photographs or video associated with the inspection.

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## 6 References

Idaho Department of Environmental Quality. 2004. Idaho Risk Evaluation Manual, July.

United States Environmental Protection Agency. 2012. Letter to Nu-West Industries, Inc. RE: Draft Section 3 (Soil Investigation and Evaluation of Results) and Sections 10.1 (Supplemental Soil Investigation) Site Assessment Report and Supplemental Site Investigation Work Plan, April 15, 2011 report, April 13.

United States Environmental Protection Agency. 2010. Regional Screening Levels, <http://www.epa.gov/region9/superfund/prg/>, revised November.

WSP Environment &Energy. 2010. Revised Sampling and Analysis Work Plan for Site Characterization, Nu-West Industries, Inc., Conda Phosphate Operations, Soda Springs, Idaho, June 29.

WSP, 2011, Work Plan for Additional Requirements, Nu-West Industries, Inc., Conda Phosphate Operations, Soda Springs, Idaho July 11.

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## 7 Acronyms

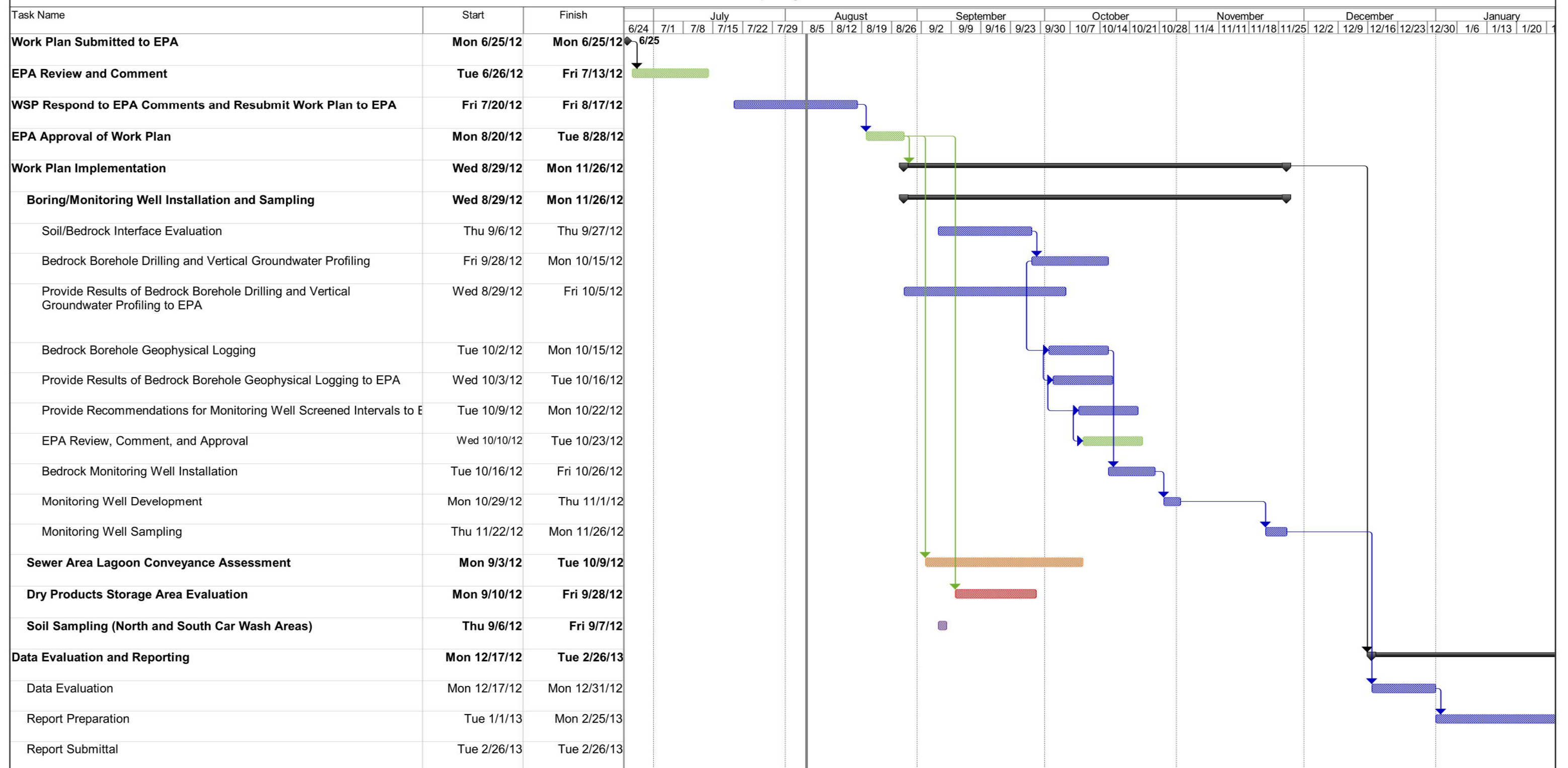
bgs	below ground surface
CFR	Code of Federal Regulations
COC	chain-of-custody
DO	dissolved oxygen
DOT	Department of Transportation
DTHH	down-the-hole-hammer
EPA	Environmental Protection Agency
IDEQ	Idaho Department of Environment Quality
IDTLs	Initial Default Target Levels
NAD	North American Datum
NAVD	North American Vertical Datum
NELAP	National Environmental Laboratory Accreditation Program
NTUs	nephelometric turbidity units
ORP	oxidation/reduction potential
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RSLs	Regional Screening Levels
SOP	standard operating procedures
TKN	total Kjeldahl nitrogen

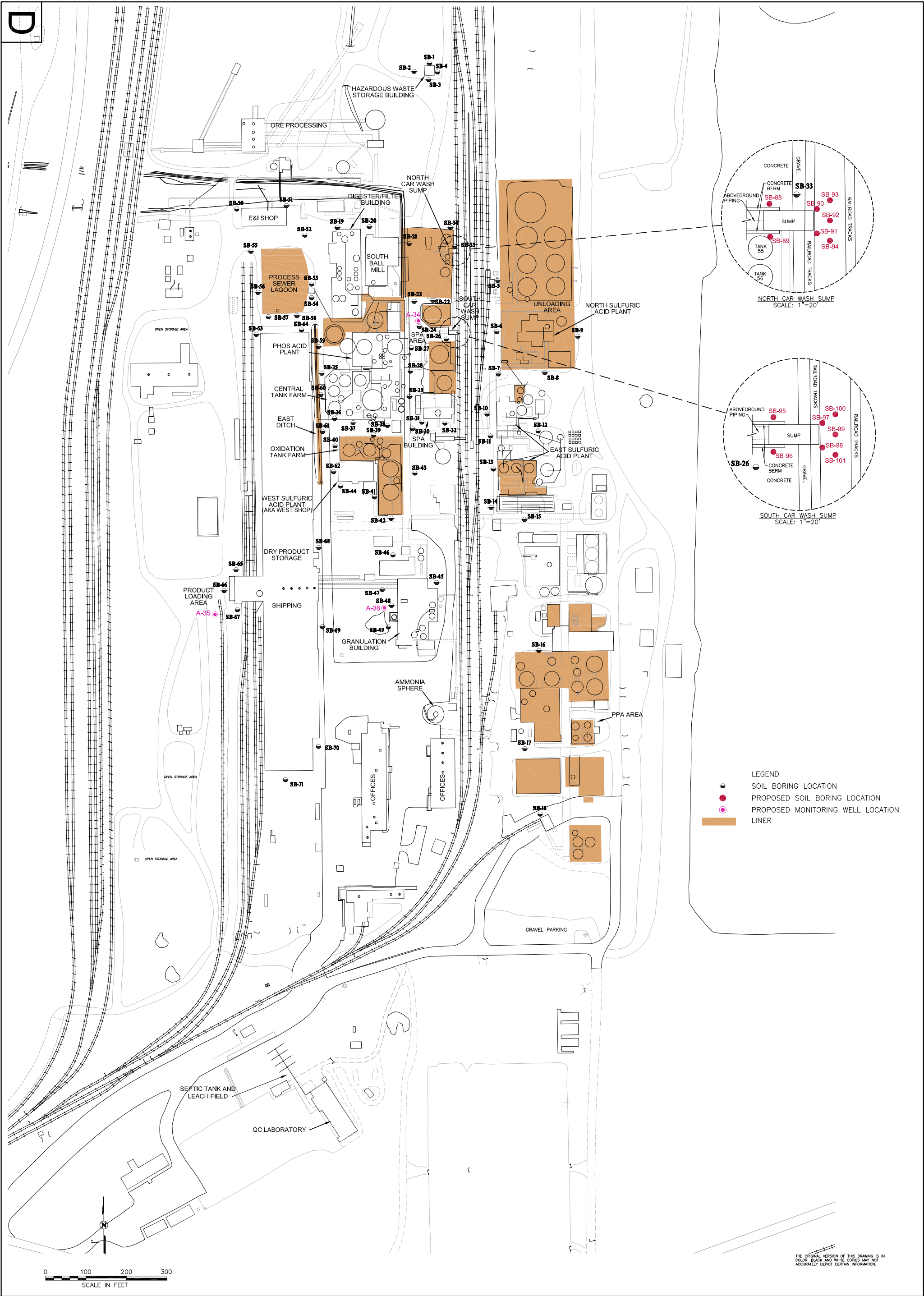
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## Figures



**Figure 1**  
Preliminary Project Schedule  
On Site Supplemental Investigation  
Nu-West CPO Facility  
Soda Springs, Idaho





- LEGEND
- SOIL BORING LOCATION
  - PROPOSED SOIL BORING LOCATION
  - PROPOSED MONITORING WELL LOCATION
  - LINER

0100230229-053

FIGURE 2

WSP Environment & Energy, LLC  
11190 Sunrise Valley Drive, Suite 300  
Reston, Virginia 20191  
(703) 709-6500  
www.wspenvironmental.com/usa

PROPOSED SOIL BORING AND MONITORING WELL LOCATIONS MAIN PROCESSING AREA

NU-WEST CPO FACILITY  
SODA SPRINGS, IDAHO  
PREPARED FOR  
HUNTON & WILLIAMS

DRAWN BY

CHECKED

APPROVED

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2	Revised: Chkd: Appr:
3	Revised: Chkd: Appr:



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## Tables

**Table 1**  
**Soil Sampling and Analytical Program, North and South Car Wash Areas**  
 Nu-West Industries, Inc.  
 Conda Phosphate Operations Facility  
 Soda Springs, Idaho

<u>Areas of Interest and Soil Boring Locations</u>		<u>Anticipated Sample Intervals</u> <sup>(a)</sup>	<u>Chemical Parameters</u>				<u>Comments</u>
			<u>Metals</u> <sup>(b)</sup>	<u>pH</u>	<u>General Chemistry</u> <sup>(c)</sup>	<u>Radiological Parameters</u> <sup>(d)</sup>	
North Car Wash Sump							
	SB-88	3	3	3	3	3	Northwest of North Car Wash Sump
	SB-89	3	3	3	3	3	Southwest of North Car Wash Sump
	SB-90	3	3	3	3	3	Northeast of North Car Wash Sump
	SB-91	3	3	3	3	3	Southeast of North Car Wash Sump
	SB-92	6	6	6	6	6	East of Sump mid-way to next tracks
	SB-93	6	6	6	6	6	Approx. 10 feet north of SB-92
	SB-94	6	6	6	6	6	Approx. 10 feet south of SB-92
South Car Wash Sump							
	SB-95	3	3	3	3	3	Northwest of South Car Wash Sump
	SB-96	3	3	3	3	3	Southwest of South Car Wash Sump
	SB-97	3	3	3	3	3	Northeast of South Car Wash Sump
	SB-98	3	3	3	3	3	Southeast of South Car Wash Sump
	SB-99	5	5	5	5	5	East of Sump mid-way to next tracks
	SB-100	5	5	5	5	5	Approx. 10 feet north of SB-99
	SB-101	5	5	5	5	5	Approx. 10 feet south of SB-99

a/ Samples will be collected from 0-1 ft bgs; 1-2 ft bgs, and 4-5 ft bgs; followed by every 5 feet until top of groundwater table or refusal at bedrock. Anticipated sample intervals based on depth to refusal at nearby soil borings. Borings proposed adjacent to Car Wash Sumps will be advanced with a hand auger, which will be limited in advancement to 5 feet bgs, based on equipment limitations.

b/ Metals include list presented in Table 2.

c/ General chemistry parameters include total phosphorus, nitrate, Total Kjeldahl Nitrogen, ammonia, and fluoride.

d/ Radiological analysis includes gross alpha and gross beta radiation. radium-226 and radium-228.

**Table 2**  
**Soil Sample Analytical Methods and Screening Levels (a)**  
 Nu-West Industries, Inc.  
 Agrium Conda Phosphate Operations Facility  
 Soda Springs, Idaho

Analytes	Test Method <sup>(b)</sup>	Method	Laboratory	EPA		Idaho Department		EPA Region 9 RSL	Background Concentrations (UTL 95-95) <sup>(f)</sup>	Comparative Values <sup>(g)</sup>	Comparative Basis	Sample Criteria <sup>(h)</sup>			
		Detection	Reporting	Soil RSLs <sup>(c)</sup>		of Environmental Quality <sup>(d)</sup>		Protection of				Container	Quantity (grams)	Preservative	Holding Time
		Limit	Limit	Industrial		Risk-Based	Critical	Groundwater <sup>(e)</sup>							
				Soil		IDTLs	Pathway	Risk-Based/MCL-Based							
Metals (mg/kg)															
Aluminum	SW-846 6010C	1.2	10	99,000	n, m	- (g)	NS	23,000/NS	15,041	23,000	GW RSL	G	100	none	180 days
Antimony	SW-846 6010C	0.1	1	41	n	4.8	GWP	0.27/0.27	0.50	0.50	background	G	100	none	180 days
Arsenic	SW-846 6010C	0.1	0.5	1.6	c	0.39	Surficial Soil	0.0013/0.29	4.7	4.7	background	G	100	none	180 days
Barium	SW-846 6010C	0.5	10	19,000	n, m	896	GWP	1,200/82	170.2	170.2	background	G	100	none	180 days
Beryllium	SW-846 6010C	0.05	0.25	200	n	1.63	GWP	13/3.2	0.89	1.63	IDTL	G	100	none	180 days
Cadmium	SW-846 6010C	0.05	0.2	80	n (i)	1.4	GWP	NS/NS	0.869	1.4	IDTL	G	100	none	180 days
Calcium	SW-846 6010C	5	250	(j)		NS	NS	NS/NS	38,270 (l)	38,270	background	G	100	none	180 days
Chromium, Total	SW-846 6010C	0.05	0.5	15,000	n, m	2,135	GWP	NS/180,000	18.61	2,135	IDTL	G	100	none	180 days
Iron	SW-846 6010C	1.7	15	72,000	n, m	5.76	GWP	270/NS	14,811	14,811	background	G	100	none	180 days
Lead	SW-846 6010C	0.05	1	80	n	50	GWP	NS/14	13.59	14	GW RSL	G	100	none	180 days
Magnesium	SW-846 6010C	5	250	(j)		NS	NS	NS/NS	7,146	7,146	background	G	100	none	180 days
Manganese	SW-846 6010C	0.05	0.75	2,300	n (i)	223	GWP	NS/NS	742 (l)	742	background	G	100	none	180 days
Nickel	SW-846 6010C	0.05	2	2,000	n	59	GWP	20/NS	15.71	20	GW RSL	G	100	none	180 days
Potassium	SW-846 6010C	25	500	(j)		NS	NS	NS/NS	3,393 (l)	3,393	background	G	100	none	180 days
Selenium	SW-846 6010C	0.2	1	510	n	2.0	GWP	0.4/0.26	1.04	1.04	background	G	100	none	180 days
Sodium	SW-846 6010C	55	500	(j)		NS	NS	NS/NS	289 (l)	289	background	G	100	none	180 days
Thallium	SW-846 6010C	0.13	0.5	1	n	1.6	GWP	0.0011/0.14	NS	0.5	RL (k)	G	100	none	180 days
Vanadium	SW-846 6010C	0.05	2.5	520	n	NS	NS	78/NS	22.68	78	GW RSL	G	100	none	180 days
General Chemistry (mg/kg)															
Fluoride (total)	EPA 9056A	1	0.5	4,100	n	7.4	GWP	NS	3.95	7	IDTL	G	100	4°C	28 days
pH (S.U.)	SW-846 9045	0.01	0.01	NS		NS	NS	NS	NS	NS	NS	G	100	4°C	ASAP
Total Phosphorous	EPA 365.3	6.7	3.35	NS		NS	NS	NS	NS	NS	NS	G	100	4°C	28 days
Total Kjeldahl Nitrogen	EPA 351.2	11	4.2	NS		NS	NS	NS	NS	NS	NS	G	100	4°C	28 days
Nitrate	EPA 9056A	1	0.5	1,600,000		18.4	GWP	NS	NS	NS	NS	G	100	4°C	48 hours
Ammonia	EPA 350.1	1.2	0.6	NS		4.1	Subsurface Soil	NS	NS	NS	NS	G	100	4°C	28 days
Radiological Parameters (pci/g)															
Gross alpha	EPA 900	NS	3 (m)	NS		NS	NS	NS	6.21	NS	NS	G or Poly	30	none	NS
Gross beta	EPA 900	NS	4 (m)	NS		NS	NS	NS	5.52	NS	NS	G or Poly	30	none	NS
Radium-226 - surface	EPA 901/HASL-300	NS	1 (m)	5		NS	NS	NS	1.958	1.958	background	G or Poly	250	none	NS
Radium-226 - subsurface	EPA 901/HASL-300	NS	1 (m)	15		NS	NS	NS	1.958	1.958	background	G or Poly	250	none	NS
Radium-228	EPA 901/HASL-300	NS	1 (m)	15		NS	NS	NS	1.756	1.756	background	G or Poly	250	none	NS

**Table 2**  
**Soil Sample Analytical Methods and Screening Levels (a)**  
 Nu-West Industries, Inc.  
 Agrium Conda Phosphate Operations Facility  
 Soda Springs, Idaho

a/ mg/kg = milligrams per kilogram; s.u. = standard units; pCi/g = picocuries per gram; "n" indicates RSL based on non-carcinogenic toxicity;  
 "m" indicates RSL may exceed the ceiling limit; "c" indicates RSL based on carcinogenic toxicity; SS indicates surficial soil as the critical pathway;  
 GWP indicates groundwater is the critical pathway; pCi/g = picoCuries per gram; RL = reporting limit  
 IDTL = Idaho default target level; G = glass; Poly = polyethylene; °C = degrees Celsius; TCL = target compound list;  
 "NS" = not applicable or standard not developed; SSLs = soil screening levels  
 UTL 95-95 = upper tolerance limits 95% confidence limit of the 95 th percentile of the distribution

- b/ SW-846 source: EPA. 1986. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. As updated and revised.  
 SM source: American Public Health Association. 1998. Standard Methods for Examination of Water and Wastewater. As updated and revised.  
 EPA sources: EPA. 1983. Methods for Chemical Analysis of Water and Waste. EPA 600/4-70-020. As updated and revised.  
 EPA. 1980. EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. EPA 600 4-80-032. As updated and revised  
 HASL source: U.S. Department of Energy. EML Procedures Manual (HASL-300). Environmental Measurements Laboratory. 28th Edition.  
 ASTM source: American Society for Testing and Materials.  
 Methods for sample preparation include SW-846 3050B for metals.  
 ASTM D3987-85, Standard Test Method for Shake Extraction of Solid Waste with Water, will be used to prepare samples for analysis of fluoride.
- c/ Soil Cleanup Criteria in 40 CFR Part 192, <http://www.epa.gov/superfund/health/conmedia/soil/cleanup.htm>  
 US EPA Regional Screening Levels (revised November 2010), <http://www.epa.gov/region9/superfund/prg/>
- d/ Idaho Risk Reduction Manual, July 2004.
- e/ US EPA Regional Screening Levels (revised May 2012), <http://www.epa.gov/region9/superfund/prg/>
- f/ background as per EPA correspondence dated April 19, 2012, except where noted)
- g/Comparative values are defined as:
- the lower of the human health screening levels, unless this value is below background
  - if the human health screening level is above background, then it is the CV
  - if the human health screening level is below background, then background is the CV
- h/ provided by Accutest Laboratories.
- i/ The RSL for diet is reported for cadmium; the RSL for non-diet is reported for manganese.
- j/ To determine potential impacts from the releases, sample concentrations for these parameters will be compared to background concentrations.
- k/ Thallium was not detected in any of the background samples. The laboratory reporting limit was identified as the screening value as the human health values are lower than the reporting and method detection limits.
- l/ Values not provided by EPA; UTL 95-95 concentrations for calcium, magnesium, potassium, and sodium calculated by WSP.
- m/ Radiochemistry labs do not use method detection limits and reporting limits that conventional labs use. Radiochemistry labs only use minimum detection concentrations as shown.

**The EPA screening values provided for non-carcinogenic parameters (n) are 1/10th of the published screening levels to account for cumulative adverse effects.**

**Table 3**  
**Groundwater Sampling and Analytical Program**  
**Nu-West Industries, Inc.**  
**Conda Phosphate Operations Facility**  
**Soda Springs, Idaho**

<b><u>Sample Location</u></b>	<b><u>Monitored Zone (e)</u></b>	<b><u>Metals (a)</u></b>	<b><u>General Chemistry (b)</u></b>	<b><u>Radiological Parameters (c)</u></b>	<b><u>Field Parameters (d)</u></b>
A-34	Soil-Bedrock	1	1	1	1
A-34	Shallow	1	1	1	1
A-34	Deep	1	1	1	1
A-35	Soil-Bedrock	1	1	1	1
A-35	Shallow	1	1	1	1
A-35	Deep	1	1	1	1
A-36	Soil-Bedrock	1	1	1	1
A-36	Shallow	1	1	1	1
A-36	Deep	1	1	1	1

a/ Samples will be field filtered for dissolved phase metals listed in Table 2.

b/ The general chemistry parameters will include Chloride, Fluoride, Nitrate, Nitrite, Total Nitrogen, Total Kjeldahl Nitrogen, Orthophosphate, Total Phosphorous, Sulfate, Sulfide, TDS, TSS, pH, Hardness (CaCO<sub>3</sub>), Alkalinity, Ammonia (total), Alkalinity (bicarbonate and carbonate), and Specific Conductance.

c/ The initial radiological parameters include total and dissolved gross alpha radiation.

Based on the results, additional testing for radium-226 and radium-228 may be performed.

d/ Field parameters include pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation/reduction potential (ORP).

e/ Soil-Bedrock corresponds to the soil/ bedrock interface;

Shallow corresponds to the first water-bearing zone within the bedrock aquifer;

Deep corresponds to the second water-bearing zone within the bedrock aquifer

**Table 4**  
**Groundwater Sample Analytical Methods**  
 Nu-West Industries, Inc.  
 Conda Phosphate Operations Facility  
 Soda Springs, Idaho

Analytes	Test Method (b)	Method Detection Limit (mg/l)	Laboratory Reporting Limit (mg/l)	EPA Maximum Contaminant Level (c) (mg/l)	Idaho Groundwater Standard (d) (mg/l)	Sample Criteria (e)			
						Quantity		Preservative	Holding Time
						Container	(ml)		
Dissolved Metals (mg/l)									
Antimony	SW-846 6010B	0.0045	0.006	0.006	0.006	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Arsenic	SW-846 6010B	0.0054	0.01	0.01	0.01	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Barium	SW-846 6010B	0.005	0.2	2	2	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Beryllium	SW-846 6010B	0.001	0.004	0.004	0.004	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Cadmium	SW-846 6010B	0.001	0.005	0.005	0.005	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Calcium	SW-846 6010B	0.1	1	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Chromium	SW-846 6010B	0.002	0.01	0.1	0.1	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Lead	SW-846 6010B	0.002	0.005	0.015	0.015	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Magnesium	SW-846 6010B	0.1	5	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Nickel	SW-846 6010B	0.0023	0.04	NS	0.209	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Potassium	SW-846 6010B	0.1	10	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Selenium	SW-846 6010B	0.0034	0.01	0.05	0.05	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Sodium	SW-846 6010B	1	20	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Thallium	EPA 200.8	0.00016	0.00125	0.002	0.002	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Vanadium	SW-846 6010B	0.0009	0.05	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
General Chemistry (mg/l)									
Chloride	EPA 300	1	2	NS	250	P	250	4°C	28 days
Fluoride	EPA 300	0.1	0.2	4	4	P	500	4°C	28 days
Nitrate as N	EPA 300	0.05	0.1	10	10	P, G	1,000	4°C; H <sub>2</sub> SO <sub>4</sub> <2 S.U.	28 days
Nitrite as N	EPA 300	0.05	0.1	1	1	P	1,000	4°C	48 hours
Total Nitrogen	SM18 4500N	0.21	0.46	NS	NS	P	500	4°C; H <sub>2</sub> SO <sub>4</sub> <2 S.U.	28 days
Total Kjeldahl Nitrogen	EPA 351.2	0.05	0.1	NS	NS	P	1,000	4°C; H <sub>2</sub> SO <sub>4</sub> <2 S.U.	28 days
Orthophosphate	EPA 365.1	0.009	0.1	NS	NS	P (f)	500	4°C	48 hours
Total Phosphorous	EPA 365.3	0.009	0.1	NS	NS	P	100	4°C; H <sub>2</sub> SO <sub>4</sub> <2 S.U.	28 days
Sulfate	EPA 300	1	2	NS	NS	P	500	4°C	28 days
Sulfide	SM4500S=F	0.6	1	NS	NS	P, G	500	4°C; NaOH+Zn acetate >9 S.U.	7 days
TDS	SM2540C	10	100	NS	500	P	100	4°C	7 days
TSS	SM2540D	4	10	NS	NS	P	100	4°C	7 days
pH (S.U.)	SM4500 H+B	0.01	0.01	NS	6.5 to 8.5	P	100	4°C	immediate
Hardness (CaCO <sub>3</sub> )	SM2340B	4	4	NS	NS	P	500	4°C; HNO <sub>3</sub> <2 S.U.	6 months
Alkalinity (total)	SM19 2320B	2.5	5	NS	NS	P	1000	4°C	14 days
Ammonia (total)	EPA 350.1	0.05	0.1	NS	NS	P	500	4°C; H <sub>2</sub> SO <sub>4</sub> <2 S.U.	28 days
Alkalinity (bicarbonate and carbonate)	SM18 4500CO2D	5	5	NS	NS	P	1000	4°C	14 days
Specific Conductance	EPA 120.1	NA	1	NS	NS	P	1000	4°C	28 days

**Table 4**  
**Groundwater Sample Analytical Methods**  
 Nu-West Industries, Inc.  
 Conda Phosphate Operations Facility  
 Soda Springs, Idaho

Analytes	Test Method (b)	Method Detection Limit (mg/l)	Laboratory Reporting Limit (mg/l)	EPA Maximum Contaminant Level (c) (mg/l)	Idaho Groundwater Standard (d) (mg/l)	Sample Criteria (e)			
						Quantity		Preservative	Holding Time
						Container	(ml)		
Radiological Parameters (pCi/l)									
Gross alpha	EPA 900	3 pCi/l	NS	15 pCi/l	15 pCi/l	P	5 liters	HNO <sub>3</sub> < 2 S.U.	6 months
Gross beta	EPA 900	4 pCi/l	NS	4 mrem/yr	15 pCi/l	P	5 liters	HNO <sub>3</sub> < 2 S.U.	6 months
Radium 226 and 228	EPA 903.0/904.0	1 pCi/l	NS	5 pCi/l	5 pCi/l	P	5 liters	HNO <sub>3</sub> < 2 S.U.	6 months

a/ mg/l = milligrams per liter; NS = not applicable or standard not developed; ml = milliliter; P = plastic; G = glass; oC = degrees Celsius; HNO<sub>3</sub> = nitric acid; H<sub>2</sub>SO<sub>4</sub> = sulfuric acid; NaOH+Zn acetate = sodium hydroxide plus zinc acetate; HCl = hydrochloric acid; S.U. = standard units; TDS = total dissolved solids; µg/l = micrograms per liter; pCi/l = picoCuries per liter; TDS will be analyzed for groundwater only.

b/ SW-846 source: EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (1986, as updated and revised).  
 SM source: American Public Health Association. Standard Methods for Examination of Water and Wastewater (1998, as updated and revised).  
 EPA sources:

EPA. Methods for Chemical Analysis of Water and Waste. EPA 600/4-70-020 (1983, as updated and revised).

EPA. EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. EPA 600 4-80-032 (1980, as updated and revised).

c/ National Primary Drinking Water Regulations, Title 40, Part 141, Appendix A, Regulated Contaminants. EPA (March 2010).

d/ Idaho Groundwater Quality Rule, Idaho Administrative Code IDAPA 58.01.11, Numerical Ground Water Quality Standards, Primary and Secondary Standards.

e/ Accutest Laboratories.

f/ Filter within 15 minutes of sampling.



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## Appendix A – WSP Standard Operating Procedures

# WSP Environment & Energy Standard Operating Field Procedures

UNITED  
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DIFFERENCE



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## Standard Operating Procedure – 1

### Note Taking and Log Book Entries

#### Materials:

Permanently bound log book (no spiral-bound log books)

Black or blue ballpoint pen (waterproof ink)

#### Procedure:

1. Use black or blue ballpoint pen with waterproof ink. Felt-tip pens should not be used.
2. Reserve the inside front cover for business cards from key personnel who visit the site (including the person in charge of the log book).
3. On the first page of the log book, place a return for reward notice, WSP's phone number, and the project manager's name.
4. Enter the following on the second page of the log book: project name, project number, project manager's name, onsite contacts, onsite telephone number and address, telephone numbers for all key personnel, and emergency fire and medical telephone numbers.
5. Number each page, initial each page, and put the date at the top of each page. Start a new page for each day. At the end of a day, summarize the day's activities, sign the page, and put a slash through the rest of the blank lines. Start the next day on a new page.
6. Enter the time (in military time, e.g., 0830) in the left column of each page when an entry is recorded in the field notebook.
7. If a mistake is made in an entry, cross out the mistake with one line and initial the end of the line.
8. At all times, maintain the chain of custody on the field log book.

#### Content:

1. Be sure that log book entries are LEGIBLE and contain accurate and inclusive documentation of project field activities.
2. Provide sufficient detail to enable others to reconstruct the activities observed.
3. Thoroughly describe all field activities while onsite. Be objective, factual, and thorough. Language should be free of personal feelings or other terminology that might prove inappropriate.
4. Describe problems, delays, and any unusual occurrences such as wrong equipment or breakdowns along with the resolutions and recommendations that resulted.
5. Fully document any deviations from or changes in the work plan.
6. Describe the weather and changes in the weather, particularly during sampling events.

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7. Sketch a map of the facility or areas onsite where activities are occurring, especially the location of sampling points.
  8. During sampling activities, record all information pertaining to the sampling event. Include descriptive locations and diagrams of the sample locations, time, sample media, analysis, sampling procedure, equipment used, sizes and types of containers, preservation and any resulting reactions, sampling identification (especially for duplicate samples), shipping procedures (record airbill numbers), and addresses.
  9. Note decontamination or disposal procedures for all equipment, samples, and protective clothing and how effectively each is performed.
  10. If possible, photograph all sample locations and areas of interest. Maintain a photographic log in the field log book and include:

Date, time, photographer, name of site, general direction faced, description of the subject taken, and sequential number of the photograph and the roll number.
  11. Record the names and affiliations of key personnel onsite each day.
  12. List all field equipment used and record field measurements, including distances, monitoring and testing instrument readings (e.g., photoionization detector (PID), organic vapor analyzer (OVA), pH, conductivity, model numbers, etc.), and calibration activities.
  13. Record proposed work schedules and changes in current schedules in the log book.
  14. Describe site security measures.
  15. Include drum inventory for all investigation-derived waste (IDW) materials generated during site activities. Provide information on how IDW material was labeled.

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## Standard Operating Procedure - 2

### Sample Container, Preservatives, & Holding Times

#### Scope:

This operating procedure describes the ways and means of selecting the appropriate sampling containers for environmental sampling.

#### Application:

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under EPA-approved protocols.

#### Materials:

Sample containers

Sample container labels

Indelible (waterproof) markers or pens

Clear tape

#### Procedures:

1. Refer to Table 1 for minimum sample volume and glassware types required for sampling a particular matrix and compound class.
2. Select the appropriate glassware (i.e., bottles or jars) from those provided by the analytical laboratory. Verify that the analytical laboratory has provided the correct number of sample containers and the correct preservatives for the project per the sampling plan requirements.
3. The analytical laboratory should always provide extra sample containers for all analytical parameters in case of breakage or other problems encountered in the field. This is particularly true for VOC sample containers (i.e., 40-ml vials).
4. Report any discrepancies or non-receipt of specific types of sample containers to the Quality Assurance Officer immediately. Arrangements should be made with the laboratory to immediately ship the missing or additional sampling containers to the project site.
5. Apply WSP sample labels to the sample containers.
6. Information on the sample labels should contain the following data:

Site/Project name

Project/Task number

Unique sample identification number

Sample date

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Time of sample collection (military system, e.g., 0000 to 2400 hours)

Analytical parameters

Preservative

Sampling personnel

7. Once sample containers are properly labeled, the sample labels should be wrapped with clear tape to prevent deterioration of sample label.
8. Proceed with the sample collection per the sampling plan requirements.
9. Collected samples should be immediately placed in an iced cooler to maintain as close as possible a 4°C atmosphere for shipment to the analytical laboratory. Follow sample shipping procedures detailed in Sample Shipping Standard Operating Procedures.
10. Recommended order of sample collection:

In-situ measurements (e.g., temperature, pH, specific conductance)

Volatile organic analytes (VOA)

Purgeable organic carbon (POC)

Purgeable organic halogens (POX)

Total organic halogens (TOX)

Total organic carbon (TOC)

Extractable organics

Total petroleum hydrocarbons (TPH)

Total metals

Dissolved metals

Microbiologicals

Phenols

Cyanide

Sulfate and chloride

Turbidity

Nitrate and ammonia

Radionuclides



**Table 1 – Sample Containers, Preservatives, and Holding Times**

<b>Analytical</b>		<b>Sampling</b>		<b>Maximum</b>
<b>Parameter</b>	<b>Matrix</b>	<b>Size and Type</b>	<b>Preservatives</b>	<b>Holding Time</b>
Metals, except mercury and hexavalent chromium	Solid	8-oz. glass jar	Cool to 4o C	180 days
Mercury	Solid	8-oz. glass jar	Cool to 4o C	28 days
Hexavalent chromium	Solid	8-oz. glass jar	Cool to 4o C	24 hours
Metals, except mercury and hexavalent chromium	Aqueous	500-ml plastic container with Teflon-lined plastic cap	HNO <sub>3</sub> , pH<2 Cool to 4o C	180 days
Mercury	Aqueous	500-ml plastic container with Teflon-lined plastic cap	HNO <sub>3</sub> , pH<2 Cool to 4o C	28 days
Hexavalent chromium	Aqueous	500-ml plastic container with Teflon-lined plastic cap	Cool to 4o C	24 hours
Volatile organics	Solid	4-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days
Volatile organics	Aqueous	Three 40-ml glass vials with Teflon-lined caps	HCl, pH<2 Cool to 4o C	14 days

<b>Analytical</b>		<b>Sampling</b>		<b>Maximum</b>
<b>Parameter</b>	<b>Matrix</b>	<b>Size and Type</b>	<b>Preservatives</b>	<b>Holding Time</b>
Semivolatile organics	Solid	8-oz. amber glass jar with Teflon-lined cap	Cool to 4o C	14 days to extraction 40 days from extraction to analysis
Semivolatile organics	Aqueous	Two 1,000-ml amber glass jars with Teflon-lined caps	Cool to 4o C	7 days to extraction 40 days from extraction to analysis
Cyanide	Solid	8-oz. glass jar	Cool to 4o C	14 days
Cyanide	Aqueous	One 500-ml plastic container	NaOH, pH>12, Cool to 4o C	14 days
TCLP Volatiles	Solid	8-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days to TCLP extraction 14 days from extraction to analysis
TCLP Semivolatile Organics	Solid	8-oz. glass jar	Cool to 4o C	14 days for TCLP extraction 7 days for preparative extraction 40 days from extraction to analysis
TCLP Metals, except Mercury	Solid	8-oz. glass jar	Cool to 4o C	180 days for TCLP extraction  180 days from preparative extraction to analysis
TCLP Mercury	Solid	8-oz. glass jar	Cool to 4o C	28 days for TCLP extraction

<b>Analytical</b>		<b>Sampling</b>		<b>Maximum</b>
<b><u>Parameter</u></b>	<b><u>Matrix</u></b>	<b><u>Size and Type</u></b>	<b><u>Preservatives</u></b>	<b><u>Holding Time</u></b>
				28 days from preparative extraction to analysis
Total Petroleum Hydrocarbons	Solid	4-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 418.1)	Aqueous	1-liter amber glass jar	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 8015 GRO)	Aqueous	2 40-ml glass vials	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 8015 DRO)	Aqueous	2 40-ml glass vials	Cool to 4o C	14 days for extraction 40 days for analysis

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## Standard Operating Procedure - 3

### Groundwater Sampling Procedures

#### Scope and Application

This groundwater sampling procedure is designed to ensure that collected groundwater samples will be representative of groundwater present in the aquifer or target formation and that the groundwater samples have not been altered or contaminated by the sampling and handling procedures. These procedures can be applied to permanently, or temporarily, installed monitoring wells, temporary wells constructed using “direct-push” techniques, wells with installed plumbing, remedial groundwater treatment systems, and excavations where groundwater is present. The topics detailed in this Standard Operating Procedure (SOP) include equipment and supply selection, equipment construction materials, and purging and sampling techniques.

#### Acronym List

bgs	below ground surface
C	Celsius
CID	casing inside diameter
DI	deionized
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DTW	depth to water
Eh	redox potential
HASP	Health and Safety Plan
L/min	liters per minute
LNAPL	light non-aqueous phase liquid
mg/l	milligrams per liter
mV	millivolts
NAPL	non-aqueous phase liquid
NTU	Nephelometric Turbidity Unit
ORP	oxygen reduction potential
pH	hydrogen ion activity
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan

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SOP	Standard Operating Procedure
SU	Standard Units
TD	total depth
TOC	top of casing
µm	micron
µS/cm	microsiemens per centimeter
VOCs	volatile organic compounds

### **Materials**

- Field notebook
- Personal Protective Equipment (PPE)
- Groundwater monitoring data log forms
- Well key(s), as needed
- Adjustable wrench or manhole wrench
- Plastic sheeting
- Air quality monitoring equipment (e.g., photoionization detector [PID]), as needed
- Flashlight or mirror
- Electronic water level indicator or interface probe
- Pump or bailers, tubing, and associated lanyard materials
- Water quality meter(s) with calibration reagents and standards
- Field test kits, as needed
- Pocket knife or scissors
- Deionized (DI) water
- Power supply, as needed
- Buckets or drum(s) for water storage
- Sample bottles, labels, indelible markers, and clear tape

### **Compulsory Prerequisites and Background Information**

Before conducting field activities, review the site Health and Safety Plan (HASP) and determine the proper level of PPE. The reader is encouraged to read this entire SOP before beginning any onsite activities. This SOP is designed to provide the user with a general outline for conducting groundwater sampling and assumes the user is familiar with basic field procedures, such as recording field notes, utility location, sample shipment procedures, sample collection and quality assurance procedures, equipment decontamination, and investigation derived waste management procedures. This SOP does not cover the development of a sampling and analysis plan, nor does it cover the selection of analytical

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procedures, or evaluation of the analytical results. These topics require a significant amount of planning and are more appropriately addressed in a site-specific work plan.

Before sampling, be sure to review the project specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures. Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques. As possible, monitoring wells or borings should be sampled by starting with the upgradient (or clean locations) and proceeding downgradient (in the order from least to most contaminated locations) for the remaining monitoring wells or borings.

### **Equipment Selection Considerations**

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. Additional supplies such as reagents, preservatives, and field measurement equipment are often necessary.

### **Pump Selection**

Groundwater sampling is accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. In selecting groundwater purging and sampling equipment, give consideration to:

- the depth of the well
- the depth to groundwater
- the volume of water to be evacuated
- the sampling and purging technique
- the analytes of interest

Sampling equipment will usually consist of peristaltic pumps, variable speed electric submersible pumps, bladder pumps, inertial lift pumps, or bailers.

- Restrictions and Precautions:
- Follow all manufacturer's instructions for assembly, operation, and maintenance specific to your equipment
- For wells where the water level is below the limit of suction (approximately 25 feet to 30 feet below ground surface, bgs), and/or where there is a large volume of water to be purged, a peristaltic pump should not be used
- Purging and sampling with an inertial lift pump (e.g., polyethylene tubing with a bottom check valve) are performed by oscillating the tubing at the intake depth to drive a column of water to the surface. Inertial lift pumps cause a surging action that may cause increased turbidity, loss of volatiles, aeration, and degassing of samples. These pumps can be used when collecting non-sensitive samples; however, should not be used for volatile organic compounds (VOCs) or gas-sensitive samples. A peristaltic pump may be attached to the sample tubing and used to pump water to the surface

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- VOCs and extractable organics should not be sampled with a peristaltic pump unless a vacuum jug or gravity method is employed and the method was previously approved.
  - Bailers may also be used for purging in appropriate situations; however, their use is discouraged by many programs. Because bailers have been shown to increase turbidity while purging and sampling, bailers should be avoided when sampling for trace element, metal, polychlorinated biphenyls, and pesticide constituents. Bailers, if improperly used, may also strip VOCs from the water column being sampled
  - Bailers with a controlled flow bottom when should be used when collecting volatile organic samples
  - Before use, install a check valve at the end of the purge tubing to prevent backflow
  - Pump housing and tubing parts must be compatible with the analytes of interest. Parts can be composed of various materials, usually polyvinyl chloride (PVC), Teflon, polyethylene, polypropylene, and stainless steel, or other non-inert materials; be sure to use non-metallic or stainless steel tubing if sampling for metals
  - Electrical cords and any cabling must be sealed in Teflon, polyethylene, or polypropylene, or be stainless steel
  - Lanyard material must be non-reactive, non-leachable material (e.g., cotton twine, nylon, stainless steel, Teflon coated, polyethylene, or polypropylene; stainless steel, Teflon coated, polyethylene and polypropylene lanyards may be decontaminated for future use

#### **Groundwater Indicator Parameter Monitoring Equipment**

WSP regularly conducts field testing for the following in-situ or field-collected parameters: groundwater level elevation, hydrogen ion activity (pH), specific conductance (conductivity), temperature, dissolved oxygen (DO), oxygen reduction potential (ORP), and turbidity. Field testing is usually conducted due to the unstable nature of these parameters; laboratory determinations will likely not be representative of field conditions.

#### **pH**

pH is a measure of the effective concentration (or activity) of hydrogen ions and is expressed as the negative base-10 logarithm of the hydrogen-ion activity in moles per liter. Uncontaminated groundwater typically exhibits a pH ranging from 5 to 9 Standard Units (SU). Changes in pH from background may indicate the presence of groundwater contamination or that existing contamination has spread and can be very useful in identifying well construction or maintenance problems.

#### **Specific conductance**

Specific conductance, or conductivity, measures the ability of water to conduct an electric current. It is generally reported in microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ), as natural waters commonly exhibit specific conductance well below 1  $\mu\text{S}/\text{cm}$ . Total dissolved solid concentrations may be approximated from specific conductance data; high readings may indicate contamination, especially if the readings are elevated compared to background. Alternatively, elevated specific conductance may indicate inadequate well development, grout contamination, or an inadequate grout seal.

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## Temperature

Temperature is not necessarily an indicator of groundwater chemical stabilization, and is generally not very sensitive in distinguishing between stagnant casing water and formation water. Nevertheless, temperature is important for data interpretation. For example, stabilized temperature readings that are representative of typical groundwater conditions help demonstrate that the sample was collected in a manner that minimized exposure to elevated temperature variations, e.g., heating from the electric motor of a submersible pump. Elevating the temperature of a sample may result in loss of VOCs or the progression of chemical reactions that may alter the sample quality in an undesirable manner.

## DO

DO has been demonstrated to be a reliable indicator of the chemical stabilization of purge water under most groundwater purging and sampling circumstances. Concentrations of DO in groundwater generally range from 1 to 4 milligrams per liter (mg/l) and should only be measured with a flow-through cell. Relatively low DO concentrations (< 1 mg/l) in groundwater may indicate the biodegradation of organic contaminants, including VOCs. DO is a good indicator when sampling for VOCs, because erratic or elevated DO readings may reflect procedures that are causing excessive agitation and aeration of the ground water being drawn from the well and subsequent loss of VOCs. Artificially aerated groundwater may also adversely affect dissolved metals analyses.

## ORP

ORP is a numerical index of the intensity of the oxidizing or reducing conditions within an aqueous solution such as ground water. Oxidizing conditions are indicated by positive potentials and reducing conditions are indicated by negative potentials. ORP measurements are generally expressed in millivolts (mV). The ORP of natural (uncontaminated) groundwater typically ranges from +500 to -100 mV. Groundwater contaminated with organic compounds generally exhibits depressed ORP values compared to background conditions and may exhibit ORP values as low as -400 mV. ORP must be measured with a flow-through cell and may not be an appropriate stabilization parameter for some groundwater conditions.

## Turbidity

Turbidity, which is the visible presence of suspended mineral and organic particles in a ground water sample, can be useful to measure during purging. Relatively high or erratic measurements may indicate inadequate well construction, development or improper sampling procedures, such as purging at an excessive rate that exceeds the well yield. Purging and sampling in a manner that produces low-turbidity water is particularly important when analyzing for total metals, which may exhibit artificially elevated concentrations in high-turbidity samples. Generally, the turbidity of in-situ groundwater is very low (at or below 10 Nephelometric Turbidity Units, NTUs); however, some groundwater zones may have natural turbidity higher than 10 NTUs.

The groundwater indicator parameters selected for field testing should be determined by the project team. Field testing of groundwater indicator parameters should be conducted with cleaned, calibrated equipment. The following procedures should be followed and all observations and measurements recorded in the field book.



- 
- Select water quality monitoring equipment that meets the project's data quality objectives and applicable regulatory requirements for field testing measurements
  - Record manufacturer name, model number, and identifying number such as a serial number for each instrument
  - Follow the manufacturer's instructions for assembly, operation, calibration, and maintenance specific to your equipment
  - Ensure that all equipment is in proper working condition, not damaged, and that batteries are properly charged before using the equipment for field testing measurements
  - Calibration of instruments should occur in the field, as close to the time of use as possible and, at least, be at the frequency suggested by the manufacturer
  - Although water quality monitoring equipment may vary in configuration or operation, project specific calibration requirements must be met
  - Document the time, date, and instrument reading of acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements
  - Document the date of receipt, expiration date, date of first use for all standards and reagents, grade and concentration (or other value) for the standard in the appropriate measurement units
  - Thoroughly rinse the instrument with DI water and fresh standards or reagents when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the instrument with fresh sample water prior to taking measurements. Residual remaining on the instrument may affect the measurement
  - If calibration fails to meet criteria, follow the manufacturer's instructions for corrective action to correct instrument performance; record discontinuation of equipment due to non-compliance with calibration failure

### **Field Measurements of Groundwater Indicator Parameters**

Indicator parameters are measured in the field to evaluate well stabilization during purging, provide information on general ground water quality, evaluate well construction, or indicate when well maintenance is needed. Indicator parameter data also may be helpful in evaluating the presence of groundwater contamination.

After calibrating the groundwater quality monitoring equipment, follow the manufacturer's instructions to select the display for readings the necessary geochemical parameters. Field testing measurements should be collected in accordance with the purge and sampling schedules provided in Sections 9.8 and 9.9. The following procedures should be followed and all observations and measurements recorded in the field book.

- Collection of field parameters should be completed within 15 minutes of sample collection
- Immerse the probe in a flow-through cell, sample cup or beaker, or at the desired depth in the well or borehole, and wait for stabilization of the reading before recording the measurement
- If collecting field measurements ex-situ, agitate or swirl the sample during the stabilization period.

- 
- Specific conductance is sensitive to temperature. If the meter is equipped with manual temperature compensation, adjust the conductivity meter to the water temperature per manufacturer's instructions. If the water temperature varies significantly from 25°Celsius (C), measure the temperature with a calibrated device, record the temperature, and correct for temperature according to the manufacturer's specifications
  - ORP meters may present redox potential (Eh) values; depending on the desired results, conversion between ORP and Eh may be necessary
  - **DO and ORP readings must be obtained in a manner in which the sample is not exposed to air prior to the measurement (e.g., flow-through cell).**

Record all field-testing measurement data, to include the following:

- Project name and location
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

### Set-Up Procedures

Once the equipment and supplies have been selected, gathered, and calibrated, prepare for groundwater sampling. As the following steps are completed, note all observations and measurements on the groundwater monitoring data log.

- Verify locations of wells or borings, media to be sampled, and analytes
- Record the approximate ambient air temperature, precipitation, wind, tidal conditions, and other field conditions the field book. In addition, any site-specific conditions or situations that could potentially alter the ground water samples or water level measurements should be recorded
- Inspect well for soundness of protective casing and surface ground seal
- Survey around the base of the well and wellhead with a PID, as necessary
- Remove the well cover and all standing water around the top of the well casing before opening the well cap
- New plastic sheeting should be placed on the ground surface around the well or boring to prevent contamination of the pumps, hoses, lanyards, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event; keep the plastic as clean as possible and replace as necessary
- Unlock and carefully remove well cap, if present; allow the groundwater level to equilibrate after removing the cap before conducting any downhole testing or measurements

- 
- Survey well casing with a PID, as necessary
  - Survey breathing zone to ensure that the level of PPE is appropriate
  - Position fuel powered equipment downwind and at least 10 feet from the well head or boring. Make sure that the exhaust faces downwind

### **Groundwater Level and Depth Measurement Procedures**

The measurement of the groundwater level in a well is frequently conducted in conjunction with groundwater sampling to determine the “free” water surface. This potentiometric surface measurement can be used to establish groundwater direction and gradients. Groundwater level and well depth measurements are needed to determine the volume of water in the well casing prior to purging the well for sampling purposes. The following procedures should be followed and all observations and measurements recorded in the field book.

- Measure and record the height of the top of the well riser above the ground; if well is a flush mount, measure and record the top of the well riser below the ground surface
- Measure the casing inside diameter (CID) and record in inches
- From the top of the casing (TOC) at the surveyor's mark, if present, measure the depth to water (DTW) to the nearest 0.01-foot with an electronic water level indicator (record in feet below TOC); if no mark is present, mark a location with a metal file or indelible marker on the north side of the casing for future reference
  - All DTW measurements must be made and recorded to the nearest 0.01 foot
  - Water level measurements from boreholes, piezometers, or monitoring wells used to define the water table or a single potentiometric surface should be collected within less than 24 hours. In certain situations, water level measurements should be made within a shorter interval, if possible:
  - Aquifers influenced by tides, recent precipitation, barometric pressure, river stage, bank storage, impoundments and/or unlined ditches, intermittent pumping of production, irrigation, or supply wells
- Total depth (TD) of the well or boring should not be conducted immediately before purging and sampling; as possible, delay purging and sampling activities for at least 24 hours after TD measurement or for a time sufficient to meet the purge stabilization criterion for turbidity. Alternately, measure TD after sample collection
  - All TD measurements must be made and recorded to the nearest 0.1 foot
  - Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Sediment in the bottom of the well can also make it difficult to determine total depth. Care must be taken in these situations to ensure accurate measurements
  - As a cautionary note, when measuring TD with an electronic water level indicator, measure and add the length of the probe beneath the circuit closing electrodes to the depth measured to obtain the true TD
- Inspect water surface in the well or boring; use flashlight if necessary. Note any observable floating product (light non-aqueous phase liquids; LNAPLs) and sinking free product layer (dense non-aqueous phase liquids; DNAPLs). Measure the thickness of the LNAPL and/or DNAPL layer using

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an appropriate interface gauging probe or a weighted tape coated with the appropriate reactive indicator paste for the suspected NAPL. DO NOT PURGE OR SAMPLE GROUNDWATER IN A WELL CONTAINING LNAPL. NAPL sampling is discussed in Section 9.9

### **Groundwater Purging**

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation that is representative of actual aquifer conditions.

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. The intent of proper purging is to stabilize the groundwater level and minimize the hydraulic stress to the hydrogeologic formation. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging completion criteria.

In order to determine when a well has been adequately purged, geochemical parameters should be monitored, at a minimum, the pH, specific conductance and turbidity of the groundwater removed during purging and, in the case of permanent monitoring wells, the volume of water removed should be observed and recorded. Document and report the following, as applicable:

- Purging rate
- Drawdown in the well, if any
- Pump or tubing intake placement.
- Length and location of the screened interval

There are several purging strategies that may be used, depending on specific conditions encountered for given sampling situations. Purging options detailed in this SOP are:

- Traditional Multiple Volume Purge
- Low-Flow Purge
- Temporary Well Purge
- Private Water Well or In-Place Plumbing Purge

No-flow groundwater sampling techniques are discussed in Section 9.8.

### **Multiple Volume or 'Traditional' Purge**

A multiple volume or 'traditional' purge involves removing a minimum of three well volumes of water before sample collection. Generally, an adequate purge is achieved when three to five volumes have been removed. The following procedures should be followed and all observations and measurements recorded in the field book.

- Calculate the volume of water in a well or boring using the following equation
- Volume (in gallons) =  $(TD - DTW) \times CID2 \times 0.041$ ; where:
- TD = total depth (feet)
- DTW = depth to water (feet)

- CID = casing inner diameter (inches)
- Alternately, the volume of water in a well or boring may also be calculated by multiplying the water column height by the gallons per foot of water for the appropriate well or boring diameter:

CID	Gallons per foot of water	Gallons per foot, three water columns
0.75-inch	0.02	0.06
1-inch	0.04	0.12
1.25-inch	0.06	0.18
2-inch	0.16	0.48
3-inch	0.37	1.11
4-inch	0.65	1.98
5-inch	1.02	3.06
6-inch	1.47	4.41
12-inch	5.88	17.61

- Calculate the total volume of the pump, associated tubing and container for in-situ measurements (flow-through cell), if used, using the following equation:  

$$\text{Volume (in gallons)} = P + ((0.0041) \cdot D^2 \cdot L) + fc; \text{ where:}$$

P = volume of pump (gallons)  
D = tubing diameter (inches)  
L = length of tubing (feet)  
fc = volume of flow-through cell (gallons)
- Install the pump or tubing to the depth prescribed in the work plan or QAPP, as dictated by the purge and sampling method
  - for wells with a completely submerged screen or if a bailer is being used, the pump, tubing or bailer should be placed above the screen at the top of the water column
  - for wells with a partially submerged screen, the pump or tubing should be placed within the middle of the saturated portion of the screened interval
- Prepare for the collection of purge water into an appropriate storage container
- Begin purging at a rate that will not cause excessive turbulence in the well; commonly less than 1 gallon per minute. Stabilization parameters should be collected every 0.5 to 1 well volume, or more frequently, record field measurements and observations of water color, suspended particulates, discoloration of casing, casing diameter and material, any unusual occurrences during sampling, and any pertinent weather details in the field book

- The minimum volume removed must be more than the volume of the pump and sampling tube capacity and the flow through cell (if used). After the minimum purge volume has been removed, review the geochemical measurements to ensure that readings have stabilized. Stabilization occurs when at least three consecutive measurements are within:

Traditional Purge Stabilization Parameters	
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 1 NTU
ORP	± 10 millivolts (flow-through cell only)

- If the geochemical measurements have not stabilized within five volumes, it is at the discretion of the project team whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity
- If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated
- If the well or borehole is purged dry before removing three well volumes, allow well or boring to recharge (commonly 90%) and proceed immediately to sample collection. If adequate sampling volume is available immediately upon completion of purging, the well should be sampled immediately. If recovery exceeds 2 hours, sample as soon as sufficient volume is available, or within 3 hours of purging. If possible, sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered
- Once purging is complete, proceed to sample collection, as described in Section 9.9

### Low-Flow Purge

Low-flow purging is generally used in low permeability units, when calculated purge volumes for traditional purging are excessive, or when vertical characterization within a screened interval is desired.

In-line flow-through cells equipped with water quality meters with continuous readout displays are highly recommended. The following procedures should be followed and all observations and measurements recorded in the field book.

- Calculate the total volume of the pump, associated tubing and container for in-situ measurements (flow-through cell), if used, using the following equation:

Volume (in gallons) =  $P + ((0.0041) \cdot D^2 \cdot L) + fc$ ; where:

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P = volume of pump (gallons)

D = tubing diameter (inches)

L = length of tubing (feet)

fc = volume of flow-through cell (gallons)

- Install the pump or tubing to the depth prescribed in the work plan or QAPP, as dictated by the purge and sampling method
  - for wells with a completely submerged screen, the open or screened interval is less than 10 feet, and the aquifer recovery rate is approximately equal to the purge rate, the intake should be placed in the middle of the screen or open interval
  - for wells with a partially submerged screen, the pump or tubing should be placed within the middle of the saturated portion of the screened interval
- Prepare for the collection of purge water into an appropriate storage container
- The pump should be started at the lowest flow volume, and adjusted higher as long as the maximum drawdown is not exceeded. Purging should not exceed 0.1 to 0.5 liters per minute (L/min)
- Water level should optimally be monitored continuously, but at a minimum, at 30 seconds to 5 minutes intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate) during purging. Ideally, a steady flow rate should be maintained that results in a stabilized water level (less than 0.3 feet of variation). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. However, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.
- If the recharge rate of the well is very low, care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. In these cases, purging should be interrupted before the water in the well reaches a level below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.
- During purging, monitor and record geochemical parameters at 30 seconds to 5 minutes intervals. Stabilization occurs once at least three equipment volumes have been purged and the following criteria have been met over three successive measurements made at least three minutes apart:



<b>Low-Flow Purge Stabilization Parameters</b>	
Water Level Drawdown	<0.3 feet
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 1 NTU
ORP	± 10 millivolts (flow-through cell only)

- Once purging is complete, proceed to sample collection, as described in Section 9.9.

#### **Temporary Well Purge**

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include open bedrock boreholes or standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. However, exposed probes that are driven through the soil to the desired water sample depth must be purged of a minimum of three probe-rod volumes of water before sampling is conducted. The longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, monitoring well purging criteria to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

Once purging is complete, proceed to sample collection, as described in Section 9.9.



### Private Water Well or In-Place Plumbing Purge

This procedure describes the method for purging domestic or other private water supply wells with in-place plumbing. The following procedures should be followed and all observations and measurements recorded in the field book.

- Obtain information regarding the exact well location, well construction details, static water depth, well depth, casing diameter, well yield, date drilled and drilling company, previous testing, presence of water treatment components, resource aquifer, and well use. Locate the well on a map for future reference
- The sampling point should be as close to the well as possible, and before the water passes through any treatment systems, heating unit, or storage system. If available, identify the cold water tap or spigot for purging and sampling
- If a suitable sampling point is not available, try to find another well at the site or take steps to minimize the impact of any potential interferences to the sample. Document in the field notebook whether you can or cannot collect a water sample before any treatment or storage components.
- If purging from a tap or faucet, try to remove any aerators, filters, or other devices from the tap before purging
- Start to purge the system by running water from a tap or outside spigot. Observe and record the purge rate for the system. Ensure that sufficient volume is pumped to allow for the complete exchange of water into equipment, holding tanks, etc.
- The minimum volume removed must be more than the volume of the pump, holding tanks, conveyance piping, etc., and the flow through cell (if used). After the minimum purge volume has been removed, review the geochemical measurements to ensure that readings have stabilized. Stabilization occurs when at least three consecutive measurements are within:

Stabilization Parameters	
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 1 NTU
ORP	± 10 millivolts (flow-through cell only)

- Once purging is complete, proceed to sample collection, as described next.

### Groundwater Sample Collection

Sampling is the process of obtaining, containerizing, and preserving (if required) a groundwater sample after the purging process is complete.

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- Once purging is complete, field measurements performed to fulfill regulatory requirements, beyond those used to measure for stabilization, should be obtained after purging and before samples are collected for analysis
  - While collecting samples, reduce the water flow to a thin stream. The flow rate should be high enough to deliver a smooth stream of water without splashing but low enough to permit filling of the sample bottles without turning the valve down during sampling; the sampling pump should be operated at a maximum rate of 0.25 L/min or the rate of the purging activities to avoid agitating the water; if using a bailer, lower the bailer slowly to avoid agitating the water
  - Field samples must be directly transferred from the sampling equipment to the container that has been specifically prepared for that given parameter; intermediate containers should be avoided.
  - Groundwater samples should be collected in the order of the volatilization (highest ability to volatilize to the lowest). Sample for VOCs first at a rate less than 0.1 L/min, taking care to remove all air bubbles from the vial and minimize agitation
  - Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:
    - VOCs
    - Purgeable organic carbon
    - Purgeable organic halogens
    - Total organic halogens
    - Total organic carbon
    - Extractable organics
    - Total metals
    - Dissolved metals
    - Phenols
    - Cyanide
    - Sulfate and chloride
    - Nitrate and ammonia
    - Radionuclides
  - If submitting samples for dissolved metals analyses or conducting field testing that use filtered samples, the sample may be field filtered
  - Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, sampler's initials, analysis, preservatives, place of collection)
  - Place clear tape over the tag or label
  - Samples for temperature-sensitive parameters should be preserved immediately after collection by placement into an insulated cooler maintained at a temperature of approximately 4°C
  - Record sample designation, date, time, and the sampler's initials on the sample tracking form and in the field book

- 
- Complete chain-of-custody forms with appropriate sampling information
  - Complete sample packing and shipping in accordance with proper procedures

### **Groundwater Filtration Procedures**

Filtered groundwater samples are sometimes used for field kit analyses and should only be collected for laboratory use after approval from the appropriate agency and/or project manager. If filtration is necessary, the following procedures should be followed and all observations and measurements recorded in the field book.

- Use a variable speed peristaltic, bladder, or submersible pump with the in-line filter fitted on the outlet end; pressurized bailers could also be used
- At the pump discharge end, attach a clean 0.45-micron ( $\mu\text{m}$ ) filter (for organics) or 0.1- $\mu\text{m}$  (for inorganics), or appropriate sized filter, to the tubing
- Turn on the pump to a rate less than 100 mL/min, hold the filter upright with the inlet and outlet in the vertical position and pump groundwater through the filter until all atmospheric oxygen has been removed and the minimum volume of water has been flushed through the filter, in accordance with the manufacturer's specifications
- Collect the filtered samples directly into the sample container from the pump-filter assembly
- If sediment is visible in the sample container after filtration, filter break-through has occurred and the sampling and filtering process should be repeated
- Disassemble the pump head and discard the tubing and filter appropriately

### **No-Flow Passive Sampling Techniques**

A number of alternate sampling devices are becoming available, including passive diffusion samplers, equilibrated grab samplers, and other in-situ sampling devices. These devices may be particularly useful to sampling low permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meet data quality objectives, and have been properly evaluated. However, the site investigator should ensure the diffusion membrane materials are selected for the contaminants of concern present at the site. Comparison tests with an approved sampling method and diffusion samplers should be completed to confirm that the method is suitable for the site. Manufacturer's specifications should be strictly followed for deployment and use of these samplers.

Equilibration time for diffusion samplers depends on the time required for the environment disturbed by deployment of the sampler to return to ambient conditions and time required by the sampler to equilibrate with the ambient water. To account for this, diffusion samplers are generally deployed a minimum of 14 days prior to sample collection. Though the sampler may be deployed for an extended period (e.g., three months or longer); the analytical results will be the average of the sample equilibration time for the analyte of concern (generally the last 1 to 4 days).

No-flow grab samplers are placed in the well before sampling and remain closed. The water is then collected when the sampler is activated. Samples are either transferred to containers at the well head or the sampler is shipped to the laboratory for analysis. Examples of equilibrated grab samples include Hydrosleeve®, Snap Sampler™, and Kemmerer Sampler.

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### **Non-Aqueous Phase Liquid Sampling**

Non-aqueous phase liquid (NAPL) is normally sampled for two reasons:

- Documentation for its existence and thickness
- Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases as it may not be possible to identify weathered product

Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable polyethylene and polypropylene bailers are also acceptable. If a NAPL is identified in a monitoring well during the water level measurement, measure its thickness in the well.

- If the thickness of the NAPL is greater than 0.01 foot or product globules are present, collect a sample using a precleaned disposable bailer by slowly lowering a bailer and allowing the bottom to sink to 1 foot below the water surface to capture LNAPL only
- Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer
- Pour a portion of the product into a glass sample container
- Follow proper sampling, packing, and shipping procedures

Before DNAPL sampling, to the extent practical, remove the full thickness of the LNAPL

- Record the quantity of LNAPL removed in the field book
- Use a peristaltic pump, inertial pump, double check valve bailer, or polyethylene tubing equipped with a bottom check valve for DNAPL sample collection
- Slowly lower the sampling equipment to the well bottom and then raise it slowly, causing as little agitation as possible
- Minimize contact of the bailer with the well casing as it is raised
- Pour a portion of the product into a glass sample container; use the bottom check valve of the bailer for transfer
- Follow proper sampling, packing, and shipping procedures

### **Closing Notes**

At the conclusion of groundwater sampling, be sure to:

- Maintain the record of all purging and sampling observations and measurements
- Remove all temporary equipment from the well or borehole
- Decontaminate equipment and supplies
- Properly manage and dispose of all investigation derived waste

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**Groundwater Monitoring Data Log**

Well No./Designation \_\_\_\_\_ Date: \_\_\_\_

**Site Data**

Site Name: \_\_\_\_\_ WSP Sampling Team \_\_\_\_

Site Address: \_\_\_\_\_ WSP project No.: \_\_\_\_

Weather Conditions: \_\_\_\_

**Well Description**

Well Location: \_\_\_\_

Well Security: \_\_\_\_

Casing Material: Inner \_\_\_\_\_ Outer \_\_\_\_

Organic Vapors (PID, OVA, TIP): \_\_\_\_\_ Wellhead ppm

Breathing Zone ppm

Nonaqueous Phase (thickness):

Reference Point (e.g., top of PVC casing):

**Purge Data**

Purge Method: .

**(Note: Allow water level to equilibrate after removing well cap)**

Total Well Depth (TD): \_\_\_\_\_ ft Depth to Water (DTW): .

Casing Inner Diameter (CID): \_\_\_\_\_ inches

To calculate well volume: Well Vol.(gal)=(CID)<sup>2</sup>(0.04)(TD-DTW)

Well Volume: \_\_\_\_\_ gal x 3=Purge Volume \_\_\_\_\_ gal

Purge Time: Begin \_\_\_\_\_ End \_\_\_\_\_

Prepurge Data: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_\_\_\_

Volume 1: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_

Volume 2: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_

Volume 3: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_

Volume 4: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_

Volume 5: Temp \_\_\_\_\_ pH \_\_\_\_\_ Spec. Cond. \_\_\_\_\_ Turb. \_\_\_\_\_ Other \_

Volume Purged: \_\_\_\_\_ Purged Dry: Yes No

Disposal Method for Purgewater:

### **Water Description**

Odor: Prepurge \_\_\_\_\_ Postpurge \_

Color: Prepurge \_\_\_\_\_ Postpurge \_

### **Sampling Data**

Sampling Method: \_\_\_\_\_

Sampling Time: Begin \_\_\_\_\_ End \_\_\_\_\_

Analytical Parameters (circle appropriate parameters):

VOCs            BNA            BNE            Total (Unfiltered) Metals

Dissolved (Filtered) Metals    TPH            PCB            Cyanide

Other: \_\_\_\_\_

Comments: \_\_\_\_\_

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## Standard Operating Procedure - 4

### Surface Water and Sediment Sampling (using hand trowel)

#### Surface Water Sampling

##### Materials:

Nitrile gloves  
Saranex or Tyvek suit  
Vinyl gloves  
Bulldog boots  
Hip-waders  
Sample containers  
Sample labels and indelible marker  
Bound field log book

##### Procedure:

1. Collection of surface water samples should be completed before collection of the stream sediment samples from the same location. This procedure will eliminate the introduction of sediment and turbulence in the surface water that is to be sampled.
2. The sampler should wear hip-waders or rubber boots and gloves, or Saranex or Tyvek sleeves duct taped onto nitrile gloves, to avoid dermal contact with the surface water.
3. Extreme caution should be exercised when wading into the stream at the sampling location to minimize disturbance of the fine sediments.
4. Because of possible unseen water hazards, two people should be present during the collection of surface water samples.
5. If collecting several surface water samples from the same surface water body, start sampling at the downstream location and progressively move upstream. The sampler should always face upstream (i.e., upcurrent) when collecting the surface water sample.
6. The surface water sample container should be placed into the flowing water and the sample should be collected from just beneath the stream surface.
7. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, and placed into a cooler for shipment to the analytical laboratory.
8. The sampling location should be described, including width of stream, depth of stream, water color, and approximate surface flow (e.g., slow, fast moving, etc.).

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9. Sampling locations should be marked with a stake or flagged for future reference. Locations should be recorded with respect to a permanent feature, if available.
  10. Complete chain of custody form with appropriate sampling information.
  11. If collecting sediment samples, proceed to collect the sample from this location.

### Sediment Sampling

#### Materials:

Hand trowels (stainless steel or Teflon)  
Nitrile gloves  
Vinyl gloves  
Tray, mixing pans, Ziploc® plastic bags  
Stainless steel or Teflon spoons  
Aluminum foil  
Saranex or Tyvek suit  
Hip-waders or rubber boots  
Sample containers  
Sample labels and indelible marker  
Bound field log book

#### Procedure:

1. The hand trowel can be used to sample shallow stream bottom sediments, where the depth of water does not exceed 1 foot, using the same procedures specified in the Standard Operating Procedures for Collection of Soils Samples Using a Hand Trowel. The sediment corer or other appropriate sampling device should be used in water deeper than 1 foot (see SOP-6).
2. The sampler should wear hip-waders or rubber boots and gloves, or Saranex or Tyvek sleeves duct taped onto nitrile gloves, to avoid dermal contact with the water.
3. Extreme caution should be exercised when wading into the stream at the sampling location to minimize disturbance of the fine sediments.
4. If collecting several sediment samples from the stream, start sampling at the downstream location and progressively move upstream. The sampler should always face upstream (into the current) when collecting the sediment sample.
5. Insert the trowel into the sediment bed and retrieve sediment. Carefully remove the trowel from the water to avoid washing sediment from the blade. The trowel blade should be tilted at a slight angle, if necessary, to drain excess water from the blade before placing the sediment in the mixing tray.



- 
6. If more sediment is needed to provide sufficient sample volume, reinsert trowel at the sample location and retrieve as before.
  7. Examine contents of tray. For volatile organic compound (VOC) samples, do not mix the sediment sample in the tray. Transfer sediment directly into sample containers, choosing your sample from various portions of the tray to simulate homogeneity.
  8. After the collection of VOC samples and before filling other sample containers, mix the contents of the tray so a homogeneous texture remains.
  9. Transfer the tray contents to the sample containers.
  10. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, wiped clean of excess sediment material, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory. Complete chain-of-custody form with appropriate sampling information.
  11. The sampling location should be described, including width of stream, depth of stream, water color, and approximate surface flow (e.g., slow, fast moving, etc.).
  12. Sampling locations should be marked with a stake or flagged for future reference. Locations should be recorded with respect to a permanent feature, if available.



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## Standard Operating Procedure - 5

### Sediment/Sludge Sampling with Ekman Dredge

#### Application:

Sediment/sludge samples can be collected with an Ekman dredge, which is normally used when collecting samples from lagoons or other aqueous systems. The dredge consists of a spring-loaded set of jaws with a brass sampling bucket that is lowered to retrieve samples. The dredge can be mounted on a pole or suspended from a line. This may not be used for samples to be analyzed for metals and organics.

#### Materials:

- Ekman dredge
- Saranex or Tyvek suit
- Overboots or hip-waders
- Stainless steel spoons or scoops
- Plastic sheeting or garbage bags
- Nitrile, surgical, or work gloves
- Trays, mixing pans, or Ziploc® plastic bags

#### Procedure:

1. Sampler should don personal protective equipment as required to prevent dermal contact with sample media.
2. Carefully open jaws of the Ekman dredge and set trip lines to trigger device.
3. Gently lower the Ekman dredge through the aqueous media until it rests on the sediment.
4. To close the jaws of the Ekman dredge, send the messenger down the line; or if the dredge is pole-mounted, strike the spring release button on the top of the pole. The weight will strike the trigger mechanism, causing the spring-loaded jaws to close. This will trap the sludge/sediment inside the sampling bucket.
5. To minimize disturbance and to avoid washing the sample from the dredge bucket, slowly retrieve the dredge through the liquid column above it.
6. The sediment sample should be removed from the dredge bucket with a stainless steel scoop or spoon and transferred directly to the labeled sample container if volatile organic compounds are being analyzed for. The remaining sediment/sludge material should be homogenized in a sampling tray before transferring to the sample container.
7. The sample container should be sealed, labeled, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.

- 
8. The sampling locations should be described including width of stream or vessel, depth of stream or vessel, and approximate surface flow rate, if applicable. Locations should be flagged or marked with a stake for future reference.
  9. Keep detailed notes in the field log book of the sample location, sample description, sample length, sampler's name, and the requested analytical parameters.
  10. Completed chain-of-custody forms with appropriate sampling information.

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## Standard Operating Procedure - 6

### Sediment Sampling Using Hand Corer

#### Application:

Sampling bottom sediment in shallow surface water bodies and lagoons

#### Materials:

Hand corer  
Extension handle  
Analyte-inert core tube liners (glass, Teflon, etc.)  
Nitrile, surgical, or work gloves  
Protective overboots  
Tray, mixing pans, or Ziploc® plastic bags  
Stainless steel spoons or trowel  
Pipe wrenches  
Bound log book

#### Assembly:

1. Secure the core tube head assembly onto the core tube, as specified by manufacturers instructions.
2. Remove end liner caps and wrapping from a clean core tube liner and insert the liner into the core tube.
3. Insert a clean core retainer into the bottom of the core tube liner so that its convex end points away from the bottom. Plastic materials should not be used if organic analytes are of concern.
4. Screw the shoe (nose cone) onto the bottom of the core tube. The hand corer is now fully assembled for use.
5. If the hand corer is used from a boat or overhead structure, either of the following two attachments can be used:
  - a) 5-foot extension handles can be attached to the top of the core head assembly with a threaded adapter fitting, nut, and bolt. The long handle is used to push the corer into bottom sediment.
  - b) The corer can be lowered to the bottom with a rope. The rope can be tied to a clevis pin that mounts on the core head assembly with a nut and bolt.

#### Use:

1. Place nitrile gloves on hands before collecting samples.

- 
2. Sampler should avoid wading into surface water, if possible. If not possible, the sampler should carefully approach the sample location to minimize disturbance of fine sediments.
  3. Place the corer in a vertical position perpendicular to the bottom at the desired sample location.
  4. The hand corer should be lowered slowly to minimize disturbance of sediments.
  5. If using the corer from a wading position push it down into the sediment while turning the handle. The push and twist technique can also be used with the long extension handle attached to the corer.
  6. If the corer is attached to a rope, detachable weights can be put on top of the core head assembly by threading the rope through the holes in the center of the weights. The shoe of the corer should not be resting on the bottom before being advanced. Further penetration will be achieved by allowing the corer to fall freely through the water while in a vertical position to strike the bottom. The weights will increase the force of the corer as it strikes the bottom.
  7. When sufficient sample has been collected, it is usually necessary to push it back and forth from different angles to loosen the seal between the bottom and the core tube before pulling it up.
  8. Slowly retrieve the core tube and place it on a clean surface in a vertical position. Slowly tilt it toward a horizontal position (this can be done immediately following retrieval of the sampling device). This will open the flapper valve and allow water that entered the tube to leak out.
  9. Unscrew and remove the core head assembly and shoe from the core tube. Pipe wrenches may be used to unscrew the core tube assembly. Slide the core tube liner out of the core tube.
  10. If undisturbed sediment core samples are needed, do not remove the sediment sample from the core tube. Retain the core sample in the core tube liner (i.e., inner sleeve) and place Teflon end caps on each liner end. Label the inner tube and tape the end caps on the tube liner for shipment to the laboratory. Plastic materials, including end cap, should not be used if organic analytes are of concern.
  11. To remove sediment from the core tube, place the core tube liner over a sampling tray and remove its contents by inserting the brass rod into the top end of the tube and pushing. The brass rod should be decontaminated and wrapped in clean aluminum foil between each use.
  12. If additional sediment is needed to provide necessary sample volume, reassemble the corer using a separate, clean core tube liner and repeat steps 1-11.
  13. For volatile organic compound (VOC) samples, do not mix the sample before sampling for VOCs. Transfer sediment from the tray directly into sample containers.
  14. Examine the contents of the tray. After the collection of VOC samples and before filling other sample containers, mix the sediment so a homogeneous particle size and texture remain.
  15. Using the stainless steel spoon, transfer the tray contents to the sample containers.
  16. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, wiped clean of excess sediment, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.
  17. Complete chain-of-custody form with appropriate sample information.
  18. The sample location should be described, including depth of the surface water body and approximate surface flow. The location should be flagged or marked for future reference, if possible.

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## Standard Operating Procedure - 7

### Sludge Sampling with Sludge Judge

#### Application:

The sludge judge is useful for obtaining a core sample of semi-liquid sludge or water and sludge. This instrument is a long, narrow polyethylene tube with a check valve on the bottom. The tube is graduated in 6-inch intervals for easy identification of sampling depth. A sludge judge may not be used for organics.

#### Materials:

- Sludge judge
- Saranex or Tyvek suit
- Sample containers, labels, and indelible marker
- Tray or mixing pans
- Aluminum foil
- Plastic sheeting or garbage bags
- Nitrile gloves
- Vinyl gloves
- Eye protection
- Over boots
- Stainless steel scoops, trowels, or spoons

#### Procedure:

1. Sampling personnel should don the appropriate personal protective equipment based on the type of material being sampled and its historical characteristics.
2. Slowly insert the sludge judge into the material being sampled.
3. When the sludge judge has filled with material, pull back on the sampler to close the check valve and retrieve the sludge sample.
4. If a liquid sample is not required, decant any liquid into a separate container or back into the vessel being sampled. Transfer the remaining sludge sample directly into a labeled sample container by pouring the sludge from the top of the sampling tube. If a liquid sample is required, decant any liquid in the tube directly into sample containers; retrieve the sludge from tube.
5. The sample container should be sealed, labeled, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.
6. Keep detailed notes in the field log book of the sample location, sample description, sample depth, sampler's name, and the requested analytical parameters.
7. Complete chain-of-custody forms with appropriate sampling information

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## Standard Operating Procedure - 8

### Sludge Sampling with Coring Tube

#### Materials:

Field log book  
Personal protective equipment (PPE)  
Coring tube  
Hammer  
Plastic tube liners  
Hack saw and replacement blades  
Mixing tray or bowl  
Plastic sheeting  
Stainless steel spoon or trowel  
Expanding ruler or tape measure

*Note:* Decontamination is not required for dedicated sampling equipment.

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Insert a plastic liner into the coring tube to collect an undisturbed sample. A plastic core catcher may be used to improve sample recovery.
3. The sample is collected by pushing or hammering the coring tube into the material to the desired depth, making sure not to exceed the length of the coring tube. Continuous core samples can be obtained from stable coreholes by re-inserting the coring device into the same core-hole. However, a new plastic liner must be placed in the coring device before each sample is collected.
4. Remove the sampler by pulling and twisting the coring tube until it breaks free from the material. This will result in a core that is approximately 2 feet long.
5. If the sample needs to be collected from a depth greater than 2 feet, place a new plastic liner into the tube and re-insert the sampler into the same core-hole and repeat Steps 3 and 4.
6. Remove the plastic liner from the coring tube and decant any excess water above the core.
7. Cut the plastic liner at the desired sample interval using a hack saw with a decontaminated blade. For VOC samples, extrude the sample material directly into a sample container. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.



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8. For all other parameters, a stainless steel spoon or trowel should be used to transfer the sample material into a decontaminated mixing tray or bowl to be homogenized. The decontaminated stainless steel spoon or trowel can be used to remove gummy or thick sludge from the tube, if required.
  9. If necessary, screen the sludge with a PID/OVA or perform a headspace analysis in accordance with SOP 22. Record the reading in the field logbook.
  10. Record the sample location, sample description, sample depth, sampler's name, and the requested analytical parameters in the field log book.
  11. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4\* Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.
  12. Complete chain-of-custody forms with appropriate sampling information.
  13. Samples should be maintained and shipped in accordance with SOP 20.
  14. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

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## Standard Operating Procedure – 9

### Soil Sampling Using Bucket Auger

#### Materials:

Field log book  
Personal protective equipment (PPE)  
Bucket augers  
Auger extension rods  
Auger handle  
Pipe wrenches (for threaded connections)  
Push pins (for snap connections)  
Stainless steel spoons or trowels  
Mixing tray or bowl  
Plastic sheeting  
Expanding ruler or tape measure

*Note:* Decontamination is not required for dedicated sampling equipment.

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Remove all vegetation or other surface material (e.g., gravel) with a hand trowel or other tool (e.g., shovel).
3. Advance the borehole to the desired sampling depth (i.e., the top of the sample interval). Attach a decontaminated auger bucket to collect the soil sample.
4. Place the auger bucket in the borehole. Grip the cross-handle with both hands and twist it clockwise to advance the auger.
5. Withdraw the auger bucket from the borehole and place it on plastic sheeting. For VOC samples, use a decontaminated stainless steel spoon or trowel to transfer the sample material directly into the appropriate sample container. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.
6. Remove the retrieved soil from the bucket with a decontaminated stainless steel spoon or trowel and place the material in a decontaminated mixing tray or bowl. If additional soil is needed to provide sufficient sample volume, repeat Step 4.
7. If necessary, screen the lead end of the auger with a PID/OVA or perform headspace analysis in accordance with SOP 22. Record the reading in the field logbook.

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8. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the sample description in the field logbook.
  9. For all other parameters, the sample material should be transferred into a decontaminated mixing tray or bowl. Use the stainless steel spoon to separate large clumps of soil material and mix the contents of the tray to a homogeneous particle size and texture.
  10. Examine the contents of the tray and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris with the stainless steel spoon.
  11. Transfer the tray contents to the appropriate sample container using a stainless steel spoon.
  12. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4\* Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.
  13. Measure and record the sample depth in the field logbook, along with the sample location, sampler name, and the requested analytical parameters.
  14. Complete the chain-of-custody form with appropriate sampling information.
  15. Samples should be maintained and shipped in accordance with SOP 20.
  16. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

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## Standard Operating Procedure - 10

### Split-Spoon Soil Sampling

#### Application:

To collect soil samples with a split-spoon sampler that is advanced and retrieved with a drill rig.

#### Materials:

Field log book

Personal protective equipment (PPE)

Split-spoon samplers

Stainless steel spoons or trowels

Mixing tray or bowl

Pipe wrenches

Expanding ruler or tape measure

*Note:* Decontamination is not required for dedicated sampling equipment.

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Ensure that the soil boring has reached the desired sample depth and that loose soil in the bottom of the boring has been cleaned out.
3. The drillers will attach a decontaminated split-spoon sampler to the lead drilling rod, lower it to the bottom of the boring, and advance the split-spoon into the undisturbed soil. Record in the field logbook the number of blows for every 6 inches the sampler is advanced.
4. When the split-spoon has reached the desired depth, the driller will retrieve the split-spoon and disconnect the split-spoon from the drilling rod.
5. Remove the head and shoe from the split-spoon and note which end of the sampler is the top and bottom. Separate the split-spoon sampler into two halves keeping all of the soil in one of the halves (if possible).
6. Measure the length of material recovered in the sampler with respect to the penetration depth and record this ratio in the field logbook.
7. If field screening for organic vapors is required, break or cut the soil core every 3 to 4 inches and quickly scan the breaks in the core material with a PID/OVA. Headspace analyses, if required, should be performed in accordance with SOP 22. Record the reading in the field logbook.

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8. For VOC samples, transfer the soil directly into the sample containers with a decontaminated stainless steel spoon. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.
  9. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the information in the field logbook or Boring Log Form (similar to the one attached).
  10. Note: the top of the split-spoon often contains float material, which is not to be included in the soil sample or sample description.
  11. If it is necessary to collect soil samples for non-volatile parameters, transfer the recovered soil to a decontaminated mixing tray or bowl with a decontaminated stainless steel spoon. Soil material lodged within the split-spoon shoe should also be placed in the mixing tray or bowl for sampling.
  12. Examine contents of the tray and remove pebbles, organic material, (e.g., roots, grass, and woody material), and other debris with the stainless steel spoon. Use the same spoon to chop apart clumps of soil and mix the contents of the tray to a homogeneous particle size and texture.
  13. Transfer the soil material to the appropriate sample containers using the stainless steel spoon.
  14. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4\* Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.
  15. Record the sample location, sample depth, sampler name, and the requested analytical parameters in the field log book.
  16. Complete the chain-of-custody form with appropriate sampling information.
  17. Samples should be maintained and shipped in accordance with SOP 20.
  18. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

SOP 10 -- Split-Spoon Soil Sampling  
Page 3 of 3



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## Standard Operating Procedure - 11

### Soil Sampling Using Hand Trowel

#### Application:

To collect surface or shallow subsurface soil samples with a hand trowel.

#### Materials:

Field log book

Personal protective equipment (PPE)

Stainless steel trowels or spoons

Mixing tray or bowl

Plastic sheeting

*Note:* Decontamination is not required for dedicated sampling equipment.

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Remove the resealable plastic bag and aluminum foil from a decontaminated stainless steel trowel or spoon.
3. Remove any vegetation or other surface material (e.g., gravel) from the sample location with a trowel or other tool (e.g., shovel).
4. Push the trowel or spoon into the soil to the desired sampling depth. If sampling a loose gravelly or sandy soil, carefully remove the trowel so that the blade approaches a horizontal position to prevent soil from falling off the blade. If sampling a stiff silty or clayey soil, it may be necessary to remove and reinsert the trowel to loosen the soil. Shallow subsurface soil samples can be collected by digging a hole (e.g., with a shovel or trowel) and collecting a soil sample at the desired depth. A decontaminated stainless steel trowel or spoon should be used for sample collection.
5. Repeat Step 4 if more soil is needed to provide sufficient sample volume.
6. If required, screen the recovered soil with a PID/OVA or perform headspace analyses in accordance with SOP 22. Record the reading in the field logbook.
7. For VOC samples, transfer soil directly into the sample container with the stainless steel trowel. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.
8. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the sample description in the field logbook.

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9. If soil samples will be collected for non-volatile parameters, use the stainless steel spoon to chop apart clumps of soil material and mix the contents of the tray to a homogeneous particle size and texture.
  10. Examine contents of the tray and remove pebbles, organic material, (e.g., roots, grass, and woody material), and other debris with a stainless steel trowel or spoon.
  11. Transfer the tray contents to the appropriate sample container using a stainless steel spoon.
  12. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4\* Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.
  13. Record the sample location, sample depth, sampler name, and the requested analytical parameters in the field log book.
  14. Complete the chain-of-custody form with appropriate sampling information.
  15. Samples should be maintained and shipped in accordance with SOP 20.
  16. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.



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## Standard Operating Procedure - 12

### Chip, Wipe, and Sweep Sampling

#### Application:

These methods of sample collection are intended for monitoring surficial contamination of nonvolatile species of analytes on porous surfaces for chip samples and smooth surfaces for wipe samples. Also included is a method for collecting dust samples from porous or non-porous surfaces.

#### Materials:

- Lab-clean sample containers of proper size and composition
- Field and travel blanks
- Site log book
- Sample analysis request forms
- Chain of custody forms
- Custody seals
- Sample seals
- Disposable surgical gloves
- Sterile wrapped gauze pad (3 in. X 3 in.)
- Appropriate pesticide (HPLC) grade solvent
- Medium-sized, laboratory-cleaned paint brush
- Medium-sized, laboratory-cleaned chisel
- Autoclaved aluminum foil
- Camera
- Distilled/deionized water

#### Procedure:

##### Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain necessary sampling and monitoring equipment. Decontaminate or pre-clean the equipment, and ensure that it is in working order.
3. Perform a general site survey and mark all sampling locations. Measure off the designated area and photo document.

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### Chip Sample Collection

1. Don a new pair of disposable surgical gloves. Remove aluminum foil wrap from the laboratory cleaned chisel or equivalent sampling device.
2. Chip the sample area horizontally, then vertically to an even depth of approximately 1/8 inch. Collect the chipped fragments using a decontaminated dustpan and bristle brush and transfer the sample directly into the labeled sample bottle. Cap the container, attach the label and custody seal, and place in a double plastic bag. Store the samples out of direct sunlight and cool to 40 Celsius.
3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete chain-of-custody forms with appropriate sampling information.

### Wipe Sample Collection

1. Don a new pair of disposable surgical gloves. Open a new sterile package of gauze pad. Soak the pad with the appropriate solvent (one in which the contaminant is most soluble). Wipe the marked surface area using firm strokes. Wipe vertically, then horizontally to ensure complete surface coverage.
2. Place the gauze pad in an appropriately prepared sample container with a Teflon-lined cap. Cap the sample container, attach the label and custody seal, and place in a double plastic bag.
3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete the chain-of-custody forms before taking the next sample.
4. A blank sample should be collected for each sampling event. This consists of a sterile gauze pad, wet with the appropriate solvent, and placed in a prepared sample container. The blank will help identify potential introduction of contaminants via the sampling methods, the pad, solvent, or sample container.
5. Store samples out of direct sunlight and cool to 40 Celsius.

### Sweep Sample Collection

1. Don a new pair of disposable surgical gloves. Sweep the measured area using a dedicated brush and collect the sample in a dedicated dustpan (pre-cleaned).
2. Transfer the sample from the dustpan to the sample container. Cap the sample container, attach the label and custody seal, and place in a double plastic bag.
3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete the chain-of-custody form before taking the next sample.
4. Store samples out of direct sunlight and cool to 40 Celsius.

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## Standard Operating Procedure - 13

### Concrete Core Sampling

#### Materials:

Concrete corer and drill  
Tap water or containers of water  
Concrete chisel  
Hammer  
Aluminum foil  
Ionic detergent  
Wet/dry vacuum  
Stiff-bristled brushes  
Sandpaper  
Nitrile gloves  
Respiratory protection  
Tyvek suits  
Paper towels  
Eye protection  
Indelible marker  
Kimwipes  
Generator (i.e., electrical power)  
Extension cord (heavy duty)  
Pipe wrenches  
Work gloves  
Garden hose

#### Procedure:

1. Clean surface area to be sampled by scrubbing it using ionic detergent (e.g., Whisk solution) and stiff-bristled brush. Rinse the surface with deionized water, then remove the water by vacuuming surface with wet/dry vacuum.
2. Remove any sealant coatings from the surface area using sandpaper or a grinder. Wash, rinse, and vacuum the surface area.

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3. Move the drill into position and connect the decontaminated concrete corer to the drill. Connect the water supply and pressure distribution tank.
  4. Establish vacuum pressure to hold core drilling rig to the floor.
  5. Lower the corer to within 2 inches of the surface, start the drill, and slowly lower the corer to the surface.
  6. Keep a steady stream of water flowing through the corer to cool the concrete, prevent the concrete core from splitting, and control fugitive dust. Do not remove corer from the hole until the required depth is reached. However, should the concrete corer become lodged, shut off power immediately to avoid injury.
  7. With the drill still operating, remove the corer from core hole and shut off. Observe the hole to see if core was removed. If the concrete core is still in the floor or the core barrel, use a concrete chisel and rubber mallet to break the core loose.
  8. When removing the core from the corer, handle the core with clean nitrile gloves.
  9. Place a label on the top of the core written with a permanent marking pen. DO NOT WRITE on the core itself, especially if volatile organic compound analysis is requested. Measure the total length of core and record it in the field log book. Wrap the core in aluminum foil and place it in a labeled sample container.
  10. Keep detailed notes in the field log book of the sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters.
  11. Complete chain-of-custody forms with appropriate sampling information

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## Standard Operating Procedure - 14

### Waste Pile Sampling

#### Application:

As with soil sampling, waste pile samples can be collected at the surface or at depth, and different equipment is required in each instance. Surface samples can be collected most efficiently with a trowel or scoop. For samples at depth, a decontaminated, clean bucket auger may be required. For a sample core, waste pile samplers may be used. To collect representative samples of a waste pile, composite samples may be required. The objectives of the sampling program will dictate the need to collect composite samples. A grid system set-up on the waste pile may also be used to collect individual or composite samples.

#### Materials:

- Stainless steel trowels or scoops
- Stainless steel spoons
- Bucket augers
- Extension rods
- Auger handle
- Pipe wrenches
- Teflon tape
- Work, nitrile, and surgical gloves
- Saranex or Tyvek suit
- Eye protection
- Respirator (if necessary)
- Analytical buckets
- Tray, mixing pans
- Ziploc® plastic bags
- Aluminum foil
- Stakes and string (grid system)
- Plastic sheeting
- HNu or other photoionization detector (PID)

#### Procedure:

1. At the desired sampling location, clear away the accumulated surface debris.

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2. The sampler should put on the correct personal protective equipment as dictated by the medium to be sampled and the project. Care should be taken to ensure that contact between the waste material and the skin, eyes, and face of the sampling personnel is prevented.
  3. If a grid system is being employed for sampling the waste pile, lay out the grid according to the developed sampling plan.
  4. Assemble the sample equipment (e.g., bucket augers) if necessary, and collect the samples at the chosen designations.
  5. Collect an adequate volume of waste from a depth of 0-6 inches using the bucket auger, trowel, or scoop at the desired sampling locations. Record the PID measurement in the open borehole.
  6. If using a bucket auger, advance the decontaminated bucket auger by turning the bucket auger clockwise into the sample medium. To remove the auger, turn the auger counter-clockwise and pull it from the borehole. This procedure is repeated until sampling is complete. If the sampled waste pile is heterogeneous, a clean, decontaminated bucket must be used every time to collect the sample of the waste material, if necessitated by the objectives of the sampling plan.
  7. If composite samples are to be collected, transfer the waste material to a clean tray or mixing pan for compositing. Report the PID measurement of the material in the tray. Use a clean, decontaminated spoon, scoop, or trowel to homogenize the sample. Remove any foreign matter (e.g., rocks, sticks, or other debris) from the tray. Transfer the waste sample directly into a prelabeled sample container. A wide-mouth sampling container is preferable for containing the sample, as it requires less disturbance of the waste sample as the sample is being transferred into the labeled sample container.
  8. Keep detailed notes in the field log book of the sample location, details about the grid spacing, sample description, sample depth, PID measurements, sampler's name, and the requested analytical parameters.
  9. Complete the chain-of-custody forms with the appropriate sampling information.

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## Standard Operating Procedure - 15

### Decontamination of Drilling Equipment

#### Materials:

Canvas or plastic tarp(s)  
4-mil polyethylene liner  
Pressurized steam cleaner (steam jenny)  
55-gallon steel drums with bung (closed) tops  
55-gallon steel drums with open tops, rings, lids, ring-nut and ring-bolt  
Hammer, nails, duct tape, extension cord(s)  
Wood boards - 4" x 4", 2" x 4" or 2" x 6"  
Portable wet/dry vacuum  
Shovel, funnel, and squeegee

#### Construction of Decontamination Basin:

1. Place tarp(s) on flat, firm surface in an accessible area of the site away from areas of surface contamination. Use enough tarp to accommodate the rear of the drilling rig and hollow stem augers and to prevent overspray from the steam jenny from falling onto adjacent soil surfaces. If necessary, place more than one tarp on the ground. Overlap tarp edges and secure with duct tape. Area should be slightly inclined toward one corner so that the decontamination water will pool in one corner for easier pumping to the containment drums.
2. Place a layer of polyethylene liner on top of the tarp(s). If one sheet cannot completely cover the tarp, use another one. Overlap the sheets at the edges and secure with duct tape.
3. Place 4" x 4" boards along the tarp's outer edges to form a square or rectangular basin. Roll each 4" x 4" board toward the center so the tarp and polyethylene wrap completely around it at least once. Secure the tarp and liner to the top of the boards with nails, tacks or heavy-duty staples.
4. Place the drums, steam cleaner, and wet/dry vacuum adjacent to one side of the basin on the outside.

#### Decontamination Procedure:

1. Unload drilling equipment from the drilling rig and place in one side of the basin.
2. Activate the steam cleaner. Personnel performing steam cleaning should don rubber boots, Tyvek or Saranex suits, rubber gloves, and a hard hat with a face shield for splash protection.
3. Clean each piece of drilling equipment, including auger bits, drill bits, portable power augers, hollow stem augers, auger holders, split spoons, rod lifters, and drilling rods, by holding the nozzle of the steam cleaner a few inches away. Wood 2" x 4"s can be placed on the basin floor to

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prevent drilling equipment from coming into contact with solids that will build up beneath it as it is being steam cleaned.

4. After each piece is cleaned, place it on rows of 2" x 4" boards in a separate area of the basin.
5. If space allows, position the rear of the drill rig in the basin and use the steam cleaner to clean off rig surfaces and the hoist and derrick as needed.
6. Reload drilling equipment onto rig and drive it out of the basin.
7. Vacuum up liquids on the basin floor with the flexible hose of the portable wet/dry vacuum. A long-handled squeegee can be used to pool liquid together to aid vacuuming.
8. Remove accumulated solids from the basin floor with a shovel and place in open-top drums. During removal of the accumulated solids, be careful so that the polyethylene liner is not torn, cut, or punctured with the shovel.
9. Empty the canister of the wet/dry vacuum into a bung-top drum using a funnel.
10. Secure and tighten tops of drums and apply appropriate hazardous waste or nonhazardous waste labels to each drum. The accumulation date should be placed on each drum. An inventory of all onsite drums should be entered into the field log book by field personnel. All drums should be marked, numbered, or labeled with an indelible marker for future reference.
11. On completion of onsite work, the properly labeled and inventoried drums should be stored within a newly constructed pad or basin until disposal is arranged. This containment area should be constructed of wooden boards with a polyethylene liner, as described above.
12. Materials used in construction of the decontamination basin or pad should be disassembled and placed into a properly labeled drum for future disposal.
13. All drilling equipment and the drill rig should be decontaminated on arrival onsite and before the start of any drilling activity. On completion of site work, the drilling equipment and rig should be decontaminated by the drilling contractor before departure from the site.



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## Standard Operating Procedure - 16

### Decontamination of Submersible Pumps

#### Materials:

- Field logbook
- Personal protective equipment (PPE)
- Polyethylene sheeting
- Garbage bags
- Nonphosphate detergent (e.g., Liquinox or Alconox)
- Tap water
- Deionized water
- Two containers (e.g., garbage cans, buckets, plastic tubs)
- Nylon brushes
- Isopropanol
- Spray bottles
- Paper towels

*Note:* To limit the potential for cross-contamination between wells, wells should be pumped in the order of increasing constituent concentrations whenever possible. This SOP assumes that dedicated tubing is being used at each well. If dedicated tubing is not being used, the tubing should also be decontaminated using the following procedures.

#### Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Prepare a decontamination area by spreading polyethylene sheeting on a firm, flat surface (if possible). Create a berm around the decontamination area to contain inadvertent spillage. A berm can be created by rolling under the edges of the polysheeting or by draping the plastic over a wooden frame, etc.
3. Place two clean containers (e.g., garbage cans, buckets, plastic tubs) on the polysheeting. Place tap water in one container with non-phosphate detergent. Place only tap water in the second container. The containers may also be lined with garbage bags.
4. If an oily film or residue is observed on the pump or leads when they are removed from the well, the pump should be sprayed with isopropanol to remove the oil and then wiped clean with paper towels before proceeding with Step 5 below. The oily rinsate should be contained in a separate container for proper disposal.

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5. Place the pump and wire leads in the container of non-phosphate detergent and tap water and scrub the exterior of the pump with a brush. Circulate the soapy solution through the pump for at least 5 minutes. Rinse the exterior of the pump and leads with additional tap water to remove excess soap (if necessary) before proceeding with Step 6.
  6. Place the pump and leads in the container of tap water and run the pump for a least 5 minutes. Run water through the pump until all residual detergent has been removed. The soapy solution and rinse water should be changed when it becomes oily or too silty.
  7. Remove the pump and leads from the rinse water. Spray off the pump thoroughly with deionized water and wipe it dry with clean paper towels. Wipe off the wire leads with a paper towel soaked with deionized water.
  8. Wrap the pump and leads in plastic sheeting or a new plastic garbage bag to prevent possible contamination during transportation. Label the sheeting or bag with the date of decontamination for future reference.
  9. Properly manage all PPE and decontamination rinsate in accordance with state and federal requirements (See SOP 26). The spent wash water and rinse water can potentially be placed in the facility's waste water treatment system. However, field personnel should obtain approval from facility personnel and from the local POTW.

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## Standard Operating Procedure - 17

### Decontamination of Water Level Indicators

#### Materials:

Field logbook  
Personal protective equipment (PPE)  
Non-phosphate detergent (e.g., Liquinox or Alconox)  
Deionized water  
Isopropanol  
Two buckets  
Spray bottles  
Paper towels

*Note:* To limit the potential for cross-contamination between wells, wells should be gauged in the order of increasing constituent concentrations whenever possible.

#### Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. If the groundwater is grossly contaminated (i.e., LNAPL or DNAPL is present), the tape should be pulled out of the well, NOT reeled up, and placed directly into a bucket of nonphosphate detergent and tap water. The tape and probe should be scrubbed with a brush to remove visible contamination. The tape and probe should then be rinsed in a second bucket of tap water before proceeding with Step 3. If persistent stains or oily films remain, apply isopropanol to a paper towel and wipe the tape and probe until clean.
3. Thoroughly wet a paper towel with deionized water from a spray bottle. Fold the paper towel over the tape and wipe it as the tape is reeled up.
4. The water level probe should also be sprayed with deionized water and wiped dry with a clean paper towel.
5. Place water level indicator in the clean carrying case or in a clean plastic bag to prevent contamination during transportation.
6. Properly manage all PPE, used paper towels, and decontamination rinsates in accordance with state and federal requirements (See SOP 26).

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## Standard Operating Procedure - 18

### Decontamination of Interface Probe

#### Materials:

Field logbook  
Personal protective equipment (PPE)  
Nonphosphate detergent (e.g., Liquinox or Alconox)  
Deionized water  
Isopropanol  
Two buckets  
Spray bottles  
Paper towels

#### Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. If the groundwater is grossly contaminated (i.e., LNAPL or DNAPL is present), the tape should be pulled out of the well, NOT reeled up, and placed directly into a bucket of nonphosphate detergent and tap water. The tape and probe should be scrubbed with a brush to remove visible contamination. The tape and probe should then be rinsed in a bucket of tap water before proceeding with Step 3. If persistent stains or oily films remain, apply isopropanol to a paper towel and wipe the tape and probe until clean.
3. Thoroughly wet a paper towel with deionized water from a spray bottle. Fold the paper towel over the tape and wipe it as the tape is reeled up.
4. The interface probe should be sprayed with deionized water and wiped dry with a clean paper towel.
5. Place the interface probe in the clean carrying case or in a clean plastic bag to prevent contamination during transportation.
6. Properly manage all PPE, used paper towels, and decontamination rinsates in accordance with state and federal requirements (See SOP 26).

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## Standard Operating Procedure - 19

### Decontamination of Sampling Equipment

#### Materials:

Field logbook  
Personal protective equipment (PPE)  
Deionized water  
10% nitric acid solution  
Nylon brushes  
Containers (e.g., garbage cans, buckets, plastic tubs)  
Nonphosphate detergent (e.g., Liquinox or Alconox)  
Isopropanol  
Aluminum foil  
Polyethylene sheeting  
Plastic garbage bags  
Paper towels  
Spray bottles  
Duct tape

*Note:* All sampling equipment must be decontaminated before shipment to the office.

#### Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Prepare a decontamination area by spreading polyethylene sheeting on a firm, flat surface (if possible). Create a berm around the decontamination area to contain inadvertent spillage. A berm can be created by rolling under the edges of the polysheeting or by draping the plastic over a wooden frame, etc.
3. Prepare a solution of nonphosphate detergent and tap water in a container.
4. Wipe sampling equipment with paper towels to remove residual soil or gross contamination. Heavy oils or grease may be removed with paper towels soaked with isopropanol.
5. Disassemble sampling equipment (e.g., split-spoon samplers and bailers). Wash equipment thoroughly in a nonphosphate detergent and hot tap water (if available) solution. Teflon bailers

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must be disassembled and the inside washed with a long-handled bottle brush or short-handled brush pulled through the bailer with rope.

6. Rinse the equipment with hot tap water (if available).
7. If the equipment will be used to collect samples for metals analysis, follow the tap water rinse with a 10% nitric acid solution rinse. Carbon steel equipment (e.g., bucket augers, split-spoons) should be rinsed with 1% nitric acid solution to reduce the potential for oxidizing the metal surfaces. Collect the nitric acid rinse in a separate bucket for proper disposal. Rinse the equipment with tap water.
8. Thoroughly rinse the equipment with deionized water.
9. Spray the equipment with isopropanol and allow to completely air dry. The solvent rinse must be collected in a separate bucket. Isopropanol is the recommended solvent for organic contaminants because it is readily available and is not a Department of Transportation hazardous material. However, other solvents (e.g., acetone, hexane, methanol) may be more effective in removing certain contaminants, such as oils or PCBs. Please note that many state programs and USEPA regions specify the solvents to be used for equipment decontamination.
10. Rinse the equipment with deionized water using at least five times the volume of solvent used in the previous step.
11. After the equipment has been allowed to completely air dry, each piece must be individually wrapped with aluminum foil (shiny side out), and then wrapped in plastic.

**Note: Decontamination solvents may introduce contaminants to environmental samples. It is very important to ensure that the equipment has completely dried before use or storage.**

12. After the final decontamination event on a project, label each piece of equipment with the date of decontamination, the initials of decontamination personnel, and the type of decontamination solutions used.
13. Note any discrepancies from standard decontamination procedures in the field logbook.
14. Field decontamination presents unique problems in disposal of decontamination solutions. The spent wash water and rinse water can potentially be placed in the facility's waste water treatment system. However, field personnel should obtain approval from facility personnel and from the local POTW. If no wastewater treatment system is present onsite, or if approval cannot be obtained from the facility and local POTW, the wash water should be containerized for offsite disposal in accordance with state and federal requirements. The volume of spent solvent generated during field decontamination should be minimal. Solvents should be collected in separate buckets and allowed to evaporate. See SOP 26 for information on managing investigation-derived wastes.
15. Paper towels soaked with solvent should be allowed to air dry and be disposed of with the general trash. Under no circumstances should any decontamination solution be disposed of on soil surfaces.

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## Standard Operating Procedure – 20

### Sample Shipping Procedures

#### Materials:

Suitable shipping container (e.g., plastic cooler or lab supplied styrofoam cooler)  
Chain-of-custody forms  
Custody seals  
WSP mailing labels  
Strapping, clear packing, or duct tape  
Ziploc® plastic bags  
Knife or scissors  
Permanent marker  
Latex or nitrile gloves  
Large plastic garbage bag  
Wet ice  
Bubble wrap or other packing material  
Universal sorbent materials  
Sample container custody seals (if required)  
Federal Express form (with WSP account number)  
Vermiculite (or commercially available cat litter)

#### Procedures:

1. For shipping purposes, samples are segregated into two classes; environmental samples and restricted articles (i.e., hazardous materials). Environmental samples can also be categorized based on expected or historical analyte levels (i.e., low or high). An environmental sample is one that is not defined as a hazardous material by the Department of Transportation (DOT, 49 CFR Part 171.8). The DOT defines a "hazardous material" as a substance which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Any material of a suspected hazardous nature, previously characterized as hazardous, or known to be hazardous is considered a restricted article.
2. In general, the two major concerns in shipping samples are protecting the samples from incidental breakage during shipment and complying with applicable DOT and courier requirements for restricted article shipments.

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3. Protecting the samples from incidental breakage can be achieved using "common sense." All samples should be packed in a manner that will not allow them to freely move about in the cooler or shipping container. Glass surfaces should not be allowed to contact each other. When possible, repack the samples in the same materials that they were originally received in from the laboratory. Each container should be cushioned with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. Shipping hazardous materials should conform to the packaging, marking, labeling, and shipping instructions identified in 49 CFR Parts 172 & 173.
  4. Environmental samples shall be packed for shipment using the following procedures:
  5. Line the shipping container with a large, heavy-duty plastic garbage bag. Place universal sorbent materials (e.g., sorbent pads) between the cooler and the heavy-duty plastic bag. The amount of sorbent material should be sufficient to absorb the volume of wet ice and aqueous samples. If using a plastic cooler, securely tape the drain plug closed on the outside of the cooler.
  6. Place 2-4 inches of bubble wrap or other packing material inside the heavy-duty plastic bag in the bottom of the cooler.
  7. The sample packer should wear latex or nitrile gloves when handling the samples during the packing process.
  8. Place the bottles in the cooler with sufficient space to allow for the addition of more bubble wrap or other packing material between the bottles. Large or heavy sample containers should be placed on the bottom of the cooler with lighter samples (i.e., VOAs) placed on top to eliminate breakage.
  9. Place the "wet ice" inside two sealed heavy-duty zipper-style plastic bags and package the bags of ice on top of or between the samples. Pack enough ice in the cooler to chill the samples during transit. If the cooler is shipped on a Friday or Saturday for Monday delivery, double the amount of ice placed in the cooler (Monday delivery should be used only as a last resort). Fill all remaining space with bubble wrap or other packing material. Securely close and seal with tape the top of the heavy-duty plastic bag.
  10. Place chain-of-custody form (and, if applicable, CLP traffic reports) into a Ziploc® plastic bag and affix to the cooler's inside lid, then close the cooler. Securely fasten the top of the cooler shut with tape. Place two signed and dated chain-of-custody seals on the top and sides of the cooler so that the cooler cannot be opened without breaking the seals.
  11. Once cooler is sealed, shake test the cooler to make sure that there are no loose sample containers in the cooler. If loose samples are detected, open the cooler and repack the samples.
  12. Using clear tape, affix a mailing label with WSP's return address to the top of the cooler.
  13. Ship samples via priority overnight express to the contracted analytical laboratory for next morning delivery. If applicable, check the appropriate box on the airbill for Saturday delivery.
  14. Declare value of samples on the shipping form for insurance purposes. The declared value should reflect the cost to recollect the samples.
  15. Record the tracking numbers from the Federal Express forms in the field notebook and on the chain of custody form. Also, retain the customer's copy of the Federal Express airbill.



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Hazardous materials should be packed according to the above procedures with the following additions:

1. Place samples in individual Ziploc® plastic bags and secure with a plastic tie or tape.
2. Place samples in paint cans in a manner which would prevent bottle breakage (i.e., do not place glass against glass).
3. Place vermiculite or other absorbent packing material in the paint can around the samples. The amount of packing material used should be sufficient to absorb the entire contents of the sample if the container is broken during shipment.
4. Secure a lid to the paint can with can clips and label the outside of the can with sample numbers and quantity. Mark the paint can with "This End Up" and arrow labels that indicate the proper upward position of the paint can.
5. Package the paint cans in DOT-authorized boxes or coolers, with appropriate DOT shipping labels and markings on two adjacent sides of the box or cooler.
6. Ship the restricted articles via overnight courier following the courier's documentation requirements. A special airbill must be completed for each shipment. Retain a copy of the airbill for WSP records and tracking purposes, if necessary.

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## Standard Operating Procedure – 21

### Field Quality Assurance/Quality Control Samples

#### Materials:

- Field logbook
- Personal protective equipment (PPE)
- Sample containers
- Sample labels
- Clear tape
- Laboratory analyte free water
- Clean or dedicated sampling equipment

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Select the appropriate glassware for the field Quality Assurance/Quality Control (QA/QC) samples. Refer to the WSP Standard Operating Procedure for Sample Container, Preservatives, and Holding Times to determine the appropriate bottles to use.
3. Field QA/QC samples include the following:
  - a. trip blanks
  - b. duplicate samples
  - c. equipment blanks
4. Trip blanks should be provided by the analytical laboratory for all projects where samples are being collected for analysis of volatile organic compounds (VOCs). Trip blanks should accompany the sample bottles from the analytical laboratory to the site, accompany the sample containers at all times during the sampling event, and return to the laboratory with the sample containers. One trip blank should be submitted to the analytical laboratory with each shipment containing samples for VOC analysis. The trip blank should be analyzed only for VOCs.
5. One duplicate sample should be collected for every 20 samples of each matrix (e.g., soil and groundwater) collected during each sampling event. Duplicate samples of soil and other solid matrices should be collected by dividing the sample material in half and alternately filling the two sample bottle sets. Duplicate samples of groundwater and other aqueous matrices should be collected by alternately filling the two sample bottle sets from the same sampling vessel (e.g., bailer). The appropriate SOP should be followed for the collection of each sample type (soil, groundwater, sediment, sludge). Duplicate samples should be analyzed for all the analytes that are being analyzed for during the sampling event.

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6. One equipment blank should be collected in the field at a rate of one per type of equipment per decontamination event not to exceed one per day. If dedicated sampling equipment is used, the equipment blanks should be prepared in the field before sampling begins. If field decontamination of sampling equipment is required, the equipment blanks should be prepared after the equipment has been used and field-decontaminated at least once. Equipment blanks should be prepared by filling or rinsing the precleaned equipment with analyte-free water and collecting the rinsate in the appropriate sample containers. The samples should be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Equipment blanks should be analyzed for all the analytes for which the environmental samples are being analyzed. Decontamination of the equipment following equipment blank procurement is not required.
  7. All QA/QC samples should be submitted to the analytical laboratory with unique sample numbers. Therefore, the QA/QC samples should be labeled as separate environmental samples following the same numbering scheme used during that particular sampling event. However, the QA/QC samples should be clearly identified on WSP's copy of the chain-of-custody form and in the field logbook.

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## Standard Operating Procedure - 22

### Soil Head Space Screening (Field Technique)

#### Materials:

PPE

Field logbook

Photoionization detector (PID) and/or Flame Ionization Detector (FID)

Aluminum foil

Clear 8-oz to 16-oz glass large-mouth containers with lids

Stainless steel spoon

Zipper-style plastic bags

#### Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.
2. Check PID to ensure that it is working properly.
3. Using WSP's standard operating procedure (SOP) for collecting soil, sludge, or sediment, half-fill a clean glass jar with sample. Place a piece of aluminum foil over the top of the jar and tightly seal the jar. Label the jar indicating the sampling location, depth, and date. Store the jar upside down until the sample is analyzed.
4. If jars are not available, collect the sample using a zipper-style plastic bag (e.g., Ziploc®). Seal and label the bag as specified in item 3.
5. Shake the sample vigorously for approximately 15 seconds.
6. If necessary, warm the sample to room temperature (70°F) by placing the jar in a heated room or vehicle. This step is very important when the ambient temperature is below 32°F.
7. After waiting approximately 15 minutes, carefully unscrew the lid of the jar without disturbing the aluminum foil. Pierce a hole through the aluminum foil using the tip of the PID. If using zipper-style bags, open the bag slightly and place the tip of the probe into the opening. Do not insert the probe into the soil and avoid the uptake of water droplets.
8. Following probe insertion, record the highest meter response. Using the foil seal/probe insertion method, maximum response should occur between 2 seconds and 5 seconds. Erratic PID response may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, the headspace data should be qualified or discounted.
9. Record the sample location, depth, soil texture (i.e., clay or sand), and PID reading in the field notebook. Also record the ambient temperature, humidity, and whether moisture was present in the jar or plastic bag. These points are important because on very cold days volatilization of organic compounds is reduced and water vapor present in the jar may cause the PID to give a false reading. Be consistent in your procedure and in your recording of the data.

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10. Duplicate 10 % of the headspace samples by collecting two samples from the same location and following items 2 through 9 above. The headspace screening data from both jars should be recorded and compared. Generally, replicate values should be consistent to plus or minus 20%.
  11. Samples collected for headspace screening should not be retained for laboratory analysis. Dispose of the soil and jar appropriately

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## Standard Operating Procedure – 23

### Underground Utility Locating

#### Application:

The purpose of this procedure is to ensure that all required and appropriate procedures are followed to locate and mark subsurface utilities (e.g., electrical lines, natural gas lines, communication lines) before initiating any intrusive field activities (e.g., drilling, test pits, trenching). Compliance with this procedure is mandatory before intrusive work can be conducted on a WSP project. This procedure is intended to allow the work to proceed safely and will minimize the potential for damaging underground utilities. Intrusive work includes all activities that require WSP's employees or their subcontractors to penetrate the ground surface. Examples of intrusive work include, but are not limited to probing, drilling, injection, test pit excavations, trenching, and remedial excavations.

#### Materials:

- Record of the communication utility locating form (Attachment 1)
- Field logbook
- Wooden stakes
- Spray paint
- Flagging tape
- As-built drawings for sub grade utilities (if available)
- Hand auger or post-hole digger
- Hand-held magnetometer or cable locator (optional, if and only if private utility locator has cleared the area and personnel have been properly trained in the use of the equipment)

#### Procedure:

##### Pre-site Mobilization

1. Gather the necessary information to complete the record of communication utility locating form (Attachment 1).
2. Contact the state utility locating service (e.g., One-Call, Miss-Dig). It is imperative to contact the locating service with sufficient lead-time to allow all utility providers to visit the site location. In each case, the state utility locating service will provide the caller with a legal dig date. Under no circumstances will intrusive work begin before the legal dig date provided by the call center. The telephone numbers for the locating service in selected states are listed in Table 1. However, the telephone number is typically listed in the area Yellow Pages. Provide the utility locating service with any information they request concerning the site and work activity in order to locate utilities at the site. Several states, including California, require that the proposed drilling locations be marked with white spray paint before contacting the locating services. The following information provided by the locating service should be documented in a record of communication utility

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locating form (Attachment 1): utility providers that will be contacted, and a utility clearance ticket number. The ticket number will be used by the various utility companies to reference the clearance request and to contact the caller with clearance verifications (see note below).

Note 1: Generally, the public utility companies will mark underground lines up to the private property boundary. However, you should request that the utility companies mark their utilities in the work areas on the site. If the utility companies will not provide that service, a private utility locating service **MUST** be contracted.

Note 2: Some utilities (e.g., sewer, water, cable TV) may not be included by the State locating service. The State locating service will provide you with a list of utilities that will be notified based on the information provided regarding the sites location. Compare this list with utilities generally expected at all sites (e.g., sewer, water, gas, communication, electric). If any expected utilities are absent from the contact list, you **MUST** contact the utilities directly for clearance before the start of intrusive activities. Record all contacts on the utility locating record of communication form.

3. Identify a site contact familiar with the utilities on the property (e.g., plant manager, facility engineer, maintenance supervisor), and provide this individual with a site plan showing the proposed locations of all soil borings, monitoring wells, test pits, and other areas where intrusive activities will be conducted. Ask the site contact for all drawings concerning underground utilities in the proposed work areas.
4. No intrusive work should be done before the legal dig date provided by the State utility locating service. No intrusive activities should be conducted along or near public right-of-ways until all utilities have been marked and visually verified in the area of investigation. In addition, NO field activities shall be conducted on private property unless the State locating service or a private utility locating service has confirmed the presence or clearance of onsite utilities.

#### Site Mobilization

1. Locate all proposed drilling and trenching locations, both onsite and offsite, with spray paint, stakes, or other appropriate markers.
2. Verify that ALL utility companies listed by the municipal locating service, and any contacted directly by WSP, have either marked the underground lines in the specified work areas or have responded with “no conflict.” Document on the utility record of communication form as each utility mark is visually confirmed.

Note: When receiving verbal clearances by telephone from utility companies, or their subcontractors, it is imperative that you verify which utilities are being cleared, particularly when dealing with subcontractors that may be marking more than one utility.

3. Review all available as-built utility diagrams and plans with the site contact to identify potential areas where underground lines may be present. The review should confirm the locations marked by the locating services and identify utilities that may have been omitted by the locating services. If the as-built drawings do not confirm utilities marked by the locating services, follow instructions in Section 6. If possible, obtain a copy(s) of the utility plans for future reference in the field.

Conduct a site walk with the site contact. During the site walk, attempt to obtain a general knowledge of the types of utilities present in the work areas. Furthermore, survey your surroundings to identify features that require electricity (e.g., parking lot lights, pad-mounted transformers) or suggest the presence of underground utilities, such as linear depressions in the

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ground. Check these items against the utility locating record of communication form checklist. For example, check to see whether major electrical lines are aboveground, or locate underground sewer lines by using the locations of manholes and storm water grates. Keep in mind that many sewer lines can be offset from catch basins.

4. A minimum of 4 feet clearance should exist between utilities and proposed drilling locations, and a minimum of 6 feet between utilities and proposed trenching locations. A minimum distance of 15 feet should be maintained by heavy equipment (e.g., excavator buckets, drill rig towers and rods) from overhead power lines. A safe distance of 25 feet should be maintained from high tension overhead power lines. In the event that work must be conducted within 25 feet of high tension wires, the lines should be wrapped and insulated by the local utilities. If a utility conflict is identified, adjust the proposed location(s) using the criteria given above. These minimum distances should be increased whenever possible to offer additional assurance that utilities will not be encountered.
5. A private utility locating service **MUST** be used for work on private property in cases where the public utility locating service does not mark utilities on the subject property. It is **NOT ACCEPTABLE** to rely on as-built drawings or verbal utility clearances. A private locator may not be necessary in rare instances; however, these cases must be discussed with the project manager **AND** a partner or executive partner of WSP before work may proceed.

A listing of several private subsurface utility locating firms is provided in Table 2. In addition, a hand-held magnetometer or magnetic-cable locating device can be used to augment, but not replace, clearance for each work area. Use of this equipment is restricted to employees with proper training on the use of hand-held utility locating equipment. Proper training is defined as having working knowledge of the manufacturer's operating procedures, and the completion of at least one successful location under the supervision of a qualified person.

6. In some cases, state and private locating services may not be able to identify all utilities. In areas where uncertainty still exists concerning the presence of underground utilities after clearance by state and private locating services, a hand auger or post-hole digger can be used to probe the shallow subsurface before using any heavy equipment (drill rig, backhoe). The probe hole should be advanced a minimum of 4 feet below ground surface at each proposed drilling or excavation location. A sufficient number of probe holes should be completed so that the area is cleared for the proposed intrusive activity. For drilling, a minimum of three holes installed in a triangular pattern should be advanced at each location. The use of hand digging methods in **NO WAY** replaces the need State and private utility locating services. Hand digging techniques should only be employed if uncertainty regarding the location of underground lines still exists after clearances by the State locating service and a private locating service.
7. Discuss the site conditions with the subcontractor and recommend that care be used at the start of the intrusive activities. Field personnel should always consider the presence of unidentified utilities at each work area. In addition, field personnel have the authority and responsibility to postpone intrusive activities if insufficient information, as stipulated in this SOP, is available, or if onsite reconnaissance identifies inconsistencies in the findings of utility locators. In these instances, field personnel should contact the project manager or a member of the health and safety committee, and an executive partner or partner of WSP before proceeding with the proposed work. The first priority on every project is to ensure that the work is conducted safely.

Again, it is the requirement of this SOP to obtain site utility clearances from the State utility locating service. If the State locating service does not provide onsite (i.e., work area) utility



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clearance, a private locating service must be contracted to clear the work areas before digging, drilling, or probing begins. Although certain instances and site conditions may appear to allow intrusive work without prior clearance, ALL deviations from this SOP MUST be approved by the project manager and a partner or executive partner BEFORE beginning intrusive work.

8. If the scope of the intrusive activity locations changes, the scope of intrusion expands or includes a new onsite or offsite area(s), review the existing information to determine whether the area(s) can be safely cleared of all potential underground utilities. If necessary, contact the state locating service and request another clearance for the new area(s) of investigation and retain a private locator in accordance with Item 5 above. Remember, the new request will provide a new legal dig date before which NO INTRUSIVE WORK CAN BEGIN. Additionally, if a clearance ticket will expire while the work is ongoing (typically after 14 days), a new clearance must be requested at before the first ticket expires so that work can continue uninterrupted. Refer to the communication utility locating form for the legal dig date time frame required by the State locating service.

9. **PUBLIC and PRIVATE UTILITY LOCATING FORM**

10. Project:\_\_\_\_\_ Project Manager:\_\_\_\_\_
11. Project Number:\_\_\_\_\_
12. Project Start Date:\_\_\_\_\_ Duration of Project:\_\_\_\_\_
13. Project Location (Site Address):\_\_\_\_\_
14. \_\_\_\_\_
15. Project Site Description (complete the following with all information available before calling):
16. Work Being Done For: (*Company or Individual Name*): \_\_\_\_\_
17. State: \_\_\_\_\_ County: \_\_\_\_\_ City/Place: \_\_\_\_\_
18. Street: \_\_\_\_\_ (*Only one street per ticket*) Zip Code: \_\_\_\_\_
19. Nearest Intersecting Street: \_\_\_\_\_
20. Lat/Long: \_\_\_\_\_ Parcel/Tax map ID: \_\_\_\_\_
21. Description of the area to be marked (*Provide the following: Street working on, which side of street, how far in which direction from nearest intersecting street; etc.*):
22. \_\_\_\_\_
23. \_\_\_\_\_
24. \_\_\_\_\_
25. \_\_\_\_\_

26.

27. Locations for proposed borings or digging identified with paint and/or stakes? (circle one): YES NO N/A

28.

29. NOW, MAKE THE CALL:

30. Call Placed to Phone No.: \_\_\_\_\_

31.

32. Date of Call: \_\_\_\_\_ Time of Call: \_\_\_\_\_ a.m. / p.m.

33. Ticket No. Assigned to Location Request: \_\_\_\_\_

34.

35. Assigned Legal Dig Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ Assigned Legal Dig Time: \_\_\_\_ AM / PM

**The Following Table Must Be Completed Before Work Can Begin:**

CALL BACK/FAX BACK INFORMATION RECORD						
	Gas	Communication	Electric	Water	Sewer	Other
Responsible Company (provided by One-Call operator)						
Date Notified						
Time Notified						
Notified By						
Phone Number						
Marks Complete						
No Conflict						
No Facilities						

Calls Made By: \_\_\_\_\_ Form Completed By: \_\_\_\_\_

Project Manager Notified of Results (initial if completed): \_\_\_\_\_

### Onsite Underground and Overhead Utility Clearance Checklist

#### Visual Confirmation of Marked Public Utilities:

Utility Type	Visual Cues	Marks Confirmed (initial)	No Markings Seen (initial)
Water	Blue Markings, fire hydrant, manholes; water meter, sprinkler heads, AST, hose bib		
Gas	Yellow Markings, gas meter, manholes; yellow bollards		
Electric	Red Markings, parking lot lights, overhead lines (telephone poles), underground vaults, manholes; conduit on buildings		
Sewer (sanitary/storm)	White or Blue Markings, underground vaults, manholes, drain grates		
Communication	Red or White Markings, red bollards, telephone poles; manholes; conduit on buildings		

#### Visual Confirmation of Marked Private Utilities (at onsite drilling/digging locations):

Utility Type	Visual Cues	Marks Confirmed	No Markings Seen (initial)	Not Applicable (initial)
Water	fire hydrant, manholes; water meter, ASTs, interior connections, hose bib, valve box			
Irrigation	sprinkler heads, hose bibs			
Gas	gas meter, manholes; yellow bollards, interior connections, valve box			
Electric	parking lot lights, interior connections, overhead lines, underground vaults, manholes, transformers/switchgear; conduit on buildings			
Sanitary/Storm/Septic System	underground vaults, manholes, drain grates, leach field, sand mound, no evidence of sanitary sewer (for septic system)			
Production Equipment	USTs (fill pipes and vent pipes), ASTs (overhead and underground pipelines), manholes/valve pits; pump islands			
Communication	Red/orange bollards, telephone poles, interior connections; manholes; conduit on buildings			

If any Utilities have "No Marking Seen" checked, private locating must be conducted to clear each drilling/digging area.

Site Visit Made By: \_\_\_\_\_

Form Completed By: \_\_\_\_\_

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## Standard Operating Procedure – 24

### Soil Sampling Using GeoProbe® System or Equivalent

#### Application:

To perform depth-discrete soil sampling with 2-foot or 4-foot long samplers using hydraulically-driven soil sampling equipment (GeoProbe® System or Equivalent).

#### Materials:

- Stainless steel soil sampler (2-foot or 4-foot long)
- Clear acetate liners
- Tape measure or expandable ruler
- Utility knife
- Photoionization detector (PID)
- Stainless steel spoons
- Aluminum tray or stainless steel mixing bowl
- Nitrile or latex gloves
- Field notebook

#### Procedure:

1. Calibrate the PID in accordance to the manufacturer's instructions. Decontaminate all down-hole sampling equipment and the utility knife, spoons, and mixing bowl per SOP 19 before initiating any boring activities. Ensure that the location is clear of all underground utilities and pipelines.
2. Attach a decontaminated 2-foot or 4-foot long stainless steel sampler fitted with a new, clear acetate liner and a decontaminated removable cutting shoe to small-diameter rods. Lower the stainless steel sampler to the top of the desired sampling depth.
3. Advance the stainless steel sampler through the desired sample interval. Record in the dedicated field notebook the interval through which the sampler was pushed.
4. After the sampler has reached the desired depth, retrieve the sampler by first removing the rods and then disconnecting the sampler. Remove the cutting shoe and acetate liner containing the soil column from the sampler. Measure the length of the material recovered relative to the interval the sampler was advanced, and record this information in the field notebook.
5. Cut the acetate liner using a utility knife to expose the recovered soil. Quickly scan the recovered soil with the PID and if necessary, immediately collect samples for VOC analysis. If the plan indicates the collection of samples for headspace analysis, collect this sample after obtaining the sample for VOC analysis per SOP 22. Record the PID readings in the field notebook.

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6. For VOC samples, transfer soil directly from the acetate liner into the sample containers with a clean, stainless steel spoon. Fill the VOC sample container with a representative sample from the entire length of the recovered sample core, or other designated sample intervals. Fill the VOC container completely, leaving no headspace.
  7. Describe the recovered soil using the Unified Soil Classification System or standard geological descriptions. Record the sample description in the field notebook.
  8. If it is necessary to mix the sample, transfer the soil from the acetate liner to a clean aluminum tray or decontaminated stainless steel mixing bowl with a decontaminated stainless steel spoon.
  9. Examine contents of the tray/bowl and remove rock fragments and organic debris, such as roots, grass, and woody material, with the stainless steel spoon. Use the same spoon to chop apart clumps of dirt and mix the contents of the tray to a homogeneous particle size and soil texture. Transfer the tray/bowl contents to the appropriate sample containers using the stainless steel spoon.
  10. The sample container(s) should be sealed, labeled, and placed in a cooler with ice or freezer packs to maintain 4° Celsius for shipment to the analytical laboratory.
  11. Complete the chain-of-custody form with the appropriate sampling information.
    - a. NJDEP's Field Sampling Procedures Manual requires the collection of soil samples for VOC analysis from the 0.5-foot interval that exhibits the highest reading during the field (PID) screening.
    - b. U.S. Environmental Protection Agency (EPA) Region 4 requires a glass bowl for homogenizing soil for sample collection.

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## Standard Operating Procedure – 25

### Groundwater Sampling Using Geoprobe® System or Equivalent

#### Application:

To perform groundwater sampling using hydraulically-driven screen point sampling equipment (GeoProbe® System or Equivalent).

#### Materials:

Stainless steel probe rods with treads sealed with Teflon® tape or O-rings  
Stainless steel screen point sampler  
Stainless steel mini-bailer  
Teflon®-coated stainless steel wire or thin nylon line  
Polyethylene tubing (3/8-inch) fitted with a stainless steel check valve  
Silicone tubing  
0.45-micron filter  
Peristaltic pump  
Sample bottles, labels, indelible markers, and clear tape  
Nitrile or latex gloves

#### Procedure:

1. Decontaminate all down-hole equipment before conducting sampling activities at each location. Ensure that the sampling location has been cleared of all underground utilities.
2. Drive the stainless steel point sampler into the subsurface material. The design of the sampler should allow the screen to remain retracted within the probe rods until it is driven to the appropriate sampling depth.
3. After reaching the desired depth, pull back on the stainless steel sheath to expose the screen. The point on the probe rods will be displaced and is not recoverable.
4. Purging is not required for probes that are sealed and opened at the target depth for sample collection. Exposed probes that are driven through the soil to the desired water sample depth must be purged of a minimum of three probe-rod volumes of water before sampling is conducted.
5. Groundwater samples can be collected using a mini-bailer lowered on Teflon®-coated stainless steel wire or nylon line inside the probe rods. Another method of sample collection involves the use of a clean section of 3/8-inch polyethylene tubing fitted with a stainless steel bottom check valve. The polyethylene tubing is inserted down the probe rods to the desired sampling depth. Oscillate the polyethylene tubing up and down to drive a column of water to the surface. A

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peristaltic pump may be attached to the sample tubing and used to pump water to the surface. The peristaltic pump should not be used to collect samples for VOC analysis.

6. Immediately collect samples for VOC analysis, if required. Transfer the groundwater directly from the sampling equipment (mini-bailer, polyethylene tubing) to the sample containers. If analyzing for dissolved metals, the sample must be filtered in the field. See note below with regards to field filtering of metal samples.
7. Seal and label each sample container and place in a cooler with ice or freezer packs to maintain 4° Celsius for shipment to the analytical laboratory.
8. Complete the chain-of-custody form with appropriate sampling information.
  - a. Where samples are collected from depths greater than 15-20 feet below the water table, a water level indicator may be inserted into the rods before exposing the screen to determine whether water is entering through the rod joints or disposable probe point.

#### Field Filtering of Metal Samples:

1. Assemble peristaltic pump per operating manual instructions that accompany the pump. Silicone tubing is generally used though the head of the pump.
2. Attach polyethylene tubing to the inflow end of the silicone tubing. The polyethylene tubing should be long enough to extend to the bottom of the screen point. Attach a clean filter to the outflow end of the silicone tubing.
3. Turn on the pump and slowly draw the water from the sampling equipment, through the pump and filter, and into the sample container. If sediment is visible in the sample container, filter break-through has occurred and the sampling and filtering process will need to be repeated.
4. Disassemble the pump head and discard the tubing and filter.

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## Standard Operating Procedure – 26

### Managing Investigation Derived Waste

#### Application:

The purpose of this SOP is to provide instructions for handling, storing, and sampling Investigation Derived Waste (IDW) pending disposal. All IDW should be handled as hazardous waste unless information exists which would allow it to be classified as non-hazardous waste. IDW generated during a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response action must be managed in compliance with applicable or relevant and appropriate requirements (ARARs) to the extent practicable and with applicable requirements of the CERCLA offsite policy. (EPA Guidance Document OERR Directive 9345.3-02)

IDW includes soil cuttings, development water, purge water, drilling fluids, decontamination fluids, personal protective equipment, and sampling equipment.

#### Materials:

Non-Hazardous and Hazardous Waste Labels  
Investigation Derived Waste Log (Figure 1)  
Permanent Ink Marking Pen Paint Stick/Pen  
Sampling Equipment (Refer to Sampling SOPs)  
Sample Jars  
Chain of Custody Forms  
Cooler

#### Procedure:

##### Hazardous IDW

1. All IDW should be handled as hazardous waste unless information exists which would allow it to be classified as non-hazardous waste. New or existing site data (i.e., soil and groundwater results) and generator knowledge can be used to classify the IDW.
- If site data or generator knowledge indicates that the IDW is determined to be hazardous the following procedures will apply:
  - The IDW must be placed in DOT approved containers (55-gallon drum, roll-off container, or temporary storage tank).
  - The containers must remain closed except when adding, sampling, or inspecting the material.
  - All containers must be labeled with the words "Hazardous Waste".



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- An accumulation start date and the contents of the container must be included on the label.
  - Investigation Derived Waste Logs (Figure 1) must be completed before leaving the site. One copy of the log should be presented to the site contact and the original provided to the project manager. Once the material has been removed from the site, the IDW log should be stamped "Removed" and placed in the project file.
  - The IDW containers must be stored in a secure onsite location (facility hazardous waste storage area if one exists).
  - Disposal of the IDW must be completed within 90 days of the date the waste was generated. If the facility is a small quantity generator, 180 days is allowed for shipment of the waste offsite.
  - Onsite disposal may be allowed or appropriate under certain conditions. Refer to OERR Directive 9345.3-02 for guidance, especially for CERCLA sites.
  - WSP personnel should notify the site contact that weekly inspections of the IDW must be conducted and documented.
  - WSP personnel should also instruct the site contact that this waste must be included in the facilities annual or biannual reports.
2. If the IDW is presumed to be hazardous and sampling is required to confirm its classification, it should be labeled Hazardous Waste-Pending Analysis. The waste should be sampled before leaving the site (See sampling SOPs). It should be noted that EPA methods 8260 and 8270 may be more cost effective than running the full Toxicity Characteristic Leaching Procedure (TCLP) scan. TSD Facilities will usually specify the required analysis for their waste profiles.

### Non-Hazardous IDW

1. If information exists to classify the IDW as non-hazardous waste, the following procedures can be implemented:

### Soil Cuttings

- Spread around the borehole or other onsite location with the approval of facility personnel
- Place back in the boring
- Containerize and dispose offsite

### Groundwater

- Pour onto ground next to well to allow infiltration
- Containerize and dispose offsite
- Discharge to POTW with approval of facility personnel
- Discharge to onsite wastewater treatment plant with approval of facility personnel

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## Decontamination Fluids

- Pour onto ground (from containers) to allow infiltration
- Containerize and dispose offsite
- Discharge to POTW with approval of facility personnel
- Discharge to onsite wastewater treatment plant with approval of facility personnel

## PPE

- Double bag and deposit in site dumpster
- Containerize and dispose offsite

If the IDW is containerized and is non-hazardous, the following procedures will apply:

- The non-hazardous IDW must be placed in DOT approved containers (55-gallon drum, roll-off container, or temporary storage tank).
- The containers should remain closed except when adding, sampling, or inspecting the material.
- All containers must be labeled with the words "Non-Hazardous Waste".
- An accumulation date and the contents of the container should be included on the label.
- Complete the IDW log (Figure 1). One copy of the log should be presented to your site contact and the original should be given to the project manager.
- The IDW containers must be stored in a secure onsite location.
- Arrangements for disposal should be completed within 90 days of the accumulation start date.

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### Investigation Derived Waste Log

Date: \_\_\_\_\_

#### Site Information

Site Name: \_\_\_\_\_ Site EPA ID #: \_\_\_\_\_

Site Contact: \_\_\_\_\_ Site Address: \_\_\_\_\_

Contact Telephone No: \_\_\_\_\_

#### Waste Identification

Type of Waste Generated (check one of the following):

- |  |                                      |  |
|--|--------------------------------------|--|
| <input type="checkbox"/> Soil Cuttings           | <input type="checkbox"/> PPE         | <input type="checkbox"/> Decontamination Water |
| <input type="checkbox"/> Groundwater             | <input type="checkbox"/> Storm Water | <input type="checkbox"/> Drilling Fluids       |
| <input type="checkbox"/> Other (Describe): _____ |                                      |  |

Field Activities that generated the Waste:

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Soil Borings            | <input type="checkbox"/> Well Sampling | <input type="checkbox"/> Well Installation |
| <input type="checkbox"/> Decon                   | <input type="checkbox"/> Excavation    | <input type="checkbox"/> Pumping Tests     |
| <input type="checkbox"/> Other (Describe): _____ |  |  |

Generation Date: \_\_\_\_\_ **90-Day Deadline:** \_\_\_\_\_

Quantity of Waste Generated and Container Type: \_\_\_\_\_

Storage Location: \_\_\_\_\_

Waste Identification (Check One of the Following);

- |   |
|---|
| <input type="checkbox"/> Non Hazardous Waste (pending analysis)                                 |
| <input type="checkbox"/> Non Hazardous Waste (based on site information or generator knowledge) |
| <input type="checkbox"/> Hazardous Waste (pending analysis)                                     |
| <input type="checkbox"/> Hazardous Waste (based on site information or generator knowledge)     |

If generator knowledge or site information was used for identification, explain: \_\_\_\_\_

Type of Label Applied to Container: ☐ Non Haz ☐ Hazardous ☐ PCB ☐ Used Oil

#### WSP Information (Note: One copy to site contact - the original in project file)

Personnel/Contact: \_\_\_\_\_ Project No.: \_\_\_\_\_  
Telephone \_\_\_\_\_

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## Standard Operating Procedure – 27

### Soil Sampling Using a Rotosonic Sampler

#### Application:

To perform soil sampling with a rotosonic drill rig sampler advanced ahead of the temporary casing.

#### Materials:

- Rotosonic samplers
- Rotosonic sample bags (plastic)
- Knife
- Photoionization detector (PID)
- Ziplock plastic bags (quart size)
- Nitrile or latex gloves
- Sample containers
- Field Notebook
- Marker

#### Procedure:

1. Decontaminate all downhole drilling and sampling equipment in accordance with the appropriate procedures before initiating any intrusive work.
2. Ensure that the temporary rotosonic casing has been advanced to immediately above the desired sample depth and loose soil in the bottom of the borehole has been removed.
3. The drillers will attach a decontaminated rotosonic sampler to the drilling rods, lower it to the bottom of the borehole, and advance the sampler through the soil using the rotosonic rig. (Note: the standard rotosonic sampler is capable of collecting a 10-foot long continuous core although 5-foot samplers may also be available. It may be desirable to advance the sampler less than 10 feet to avoid penetrating relatively thin confining layers.)
4. After the sampler has penetrated the desired sample interval, the drillers will retrieve the sampler and disconnect it from the drilling rods.
5. The drillers will place a 4-inch diameter plastic bag over the bottom end of the sampler and vibrate the rotosonic drill head until the sample is extruded from the core barrel and fills the bag. After filling, remove the bag and place it on plastic sheeting for examination and screening. Note the orientation of the sample (i.e., which end is “up”) and the depth interval. Be sure the examination/screening area is far enough away from the drilling rig exhaust pipe or other potential sources of contaminants that could affect the screening results.
6. Wearing new gloves, cut the sample bag lengthwise using a decontaminated knife. Immediately scan the recovered soil material with a PID at approximately 2-foot intervals and record the readings in the field notebook.
7. Collect samples for soil headspace analysis using the procedure described in WSP’s SOP 22 or other approved method/guidance. Record all headspace readings in the field notebook.a
8. If soil samples are being collected for VOC analysis, immediately transfer soil directly from the recovered core into the appropriate sample container(s). Collect the sample from the desired depth based on the sampling plan or field screening results. Label the container(s) with the

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sample name, depth, date and time of collection, sampler name, and analysis requested. Immediately place the containers in a cooler with ice to maintain a temperature at 4oC.

9. Collect samples for other parameters, as needed, in accordance with the sampling plan.
10. Describe the recovered soil using the Unified Soil Classification System or standard geological descriptions, and include PID measurements, sample number(s) and depth(s), and observations such as staining or odor. Write all descriptive information in the field notebook.
11. Complete the chain-of-custody form with the appropriate sampling information.

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## Standard Operating Procedure – 28

### Sampling of Private Water Supply Wells

#### Scope:

This procedure describes the method for collecting representative groundwater samples from a domestic or other private water supply well.

#### Materials:

- Business cards
- Field notebook
- Temperature, pH, and conductivity meter(s)
- Sample containers
- Cooler
- Labels
- Indelible markers
- Nitrile or latex gloves
- Chain of custody forms
- Bucket or pail (1 or 2-gallon)
- Paper towels or Kimwipes

#### Pre-Sampling Activities:

1. Verify the location of the well to be sampled and analytical parameters as specified in the sampling plan.
2. Contact the well owner and explain the scope of work. If no information has been obtained about the well, try to obtain information from the owner regarding the exact well location, well construction details, static water depth, well depth, casing diameter, well yield, date drilled and drilling company, previous testing, presence of water treatment components, resource aquifer, and well use. Locate the well on a site or USGS topographic map for future reference.
3. If insufficient well information is obtained from the owner, consider performing a water well survey to obtain the information.

#### Sampling Procedures:

1. Prepare the field notebook with description of site, well location and owner, weather conditions, sampling personnel, and other relevant observations.
2. Inspect the well to verify construction and other information concerning the well.
3. Identify a cold water tap or spigot for sample collection. The sampling point should be as close to the well as possible, and before the water passes through any treatment systems, heating unit, or storage system. If a suitable sampling point is not available, try to find another well at the site or take steps to minimize the impact of any potential interferences to the sample. Document in the field notebook whether you can or cannot collect a water sample before any treatment or storage components.
4. If sampling from a tap or faucet, try to remove any aerators, filters, or other devices from the tap before purging. If the sampling point is outside, consider removing any hoses connected to the spigot. (However, hoses may be allowed to remain attached during purging to divert large volumes of water from buildings, septic systems, etc).

5. Start to purge the system by running water from a tap or outside spigot. Use a small bucket or pail and watch to determine the purge rate for the system. If the water sample is to be collected from a tap located after a pressurization or holding tank, a sufficient volume should be pumped from the well to allow for the complete exchange of water into the holding tank and the point where the sample is to be collected.
6. Geochemical measurements (pH, conductivity, and temperature) of the water should be collected at regular intervals (every 1-2 minutes) after the start of purging. Record all measurements in the field notebook.
7. Review the geochemical measurements to ensure that readings have stabilized (within 10% of the previous reading). If the geochemical measurements have not stabilized, continue to purge the well until the measurements do not vary more than 10% between two successive measurements (if possible).
8. Collect the groundwater samples after purging is complete. While collecting samples, reduce the water flow to a thin stream. The flow rate should be high enough to deliver a smooth stream of water without splashing but low enough to permit filling of the sample bottles without turning the valve down during sampling. Collect the samples in accordance with the procedures described in WSP's SOP 2 – Sample Containers Preservatives and Holding Times. Label each container with the site name, sample name, date and time of collection, samplers, preservatives (if added), and analyses. Place the sample containers in a rigid cooler with ice maintained at a minimum of 40C.
9. Decontaminate all field meters and other non-disposable equipment, and properly dispose of any used paper towels, gloves, etc.
10. Complete chain-of-custody forms with appropriate sampling information.

**RECORD OF COMMUNICATION  
UTILITY LOCATING FORM**

Date of Call: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Time of Call: \_\_\_\_ a.m. / p.m.

Name of Utility Service Protection Center Called: \_\_\_\_\_

Call Placed to Phone No.: ( \_\_\_\_ ) \_\_\_\_ - \_\_\_\_

Call taken by operator: \_\_\_\_\_

Ticket No. Assigned to Location Request:

Co. ID # (if assigned by Utility Service Protection Center): \_\_\_\_\_

Person Calling \_\_\_\_\_ Company Phone: ( \_\_\_\_ ) \_\_\_\_ - \_\_\_\_

Alternate Contact Name: \_\_\_\_\_ Alternate Contact Phone: ( \_\_\_\_ ) \_\_\_\_ - \_\_\_\_

Company Address: \_\_\_\_\_

Assigned Start Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ a.m. (8:00 – 12:00) / p.m. (12:00 – 5:00)

Type of Work: \_\_\_\_\_

Use of Explosives: Y / N

Potential Boring Locations Identified with White Paint and/or Stakes:

Y / N / Not Applicable

Work Being Done For: (Company or Individual Name): \_\_\_\_\_

State: \_\_\_\_\_ County: \_\_\_\_\_ City/Place: \_\_\_\_\_

Street: \_\_\_\_\_ (Only one street per ticket) Zip Code: \_\_\_\_\_

Nearest Intersecting Street: \_\_\_\_\_

Map Page: \_\_\_\_\_ Grid(s): \_\_\_\_\_

Description of the area to be marked (Provide the following: Street working on, which side of street, how far in which direction from nearest intersecting street; etc.):  
\_\_\_\_\_  
\_\_\_\_\_

Map of the area to be marked faxed to the Utility Service Protection Center: Y / N / Not Accepted

Utility Service Protection Center Fax No.: ( ) - \_\_\_\_\_

**CALL BACK INFORMATION RECORD**

	Gas	Tele.	Elec.	Wtr.	Swr.	Cable TV	Other
Date Notified							
Time Notified							
Notified By							
Phone Number							
Marks Complete							
No Conflict							
No Facilities							



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## Standard Operating Procedure – 29

### Aquifer Pumping Tests

#### Scope:

This standard operating procedure (SOP) describes the methods and techniques used to perform aquifer pumping tests on partially- or fully-penetrating test wells.

#### Objective:

Aquifer tests are generally performed to measure the hydraulic characteristics of a water bearing zone that has been identified and partially characterized (e.g., total depth of the water-bearing unit, groundwater flow direction, texture of the matrix, etc.) by investigations at the site. The tests generally include four separate phases: a background monitoring phase; a stepped-rate pumping test; a constant-rate pumping test; and a recovery test. Aquifer tests typically include a pumping well where the aquifer is stressed by removing formation water, and at least one observation well where the response to pumping is measured.

This SOP is designed to provide the user with a general outline for conducting each phase of the aquifer test and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), well gauging (SOP 3) and equipment decontamination (SOPs 16 through 19). This SOP does not cover aquifer test planning (e.g., layout of the pumping and observation wells, estimation of pumping rates, selection of pump types, etc.) nor does it cover the analysis of the aquifer test results for determining the characteristics of the water-bearing zone. These topics require a significant amount of planning and are more appropriately addressed in the work plan or a dedicated aquifer test plan.

These procedures are oriented towards In situ-brand transducers and data loggers, which are the current state-of-the-art and the brand most often used by WSP. While some specifics may be slightly different for other brands of monitoring equipment, the overall sequence of work should be similar and readily adaptable to any equipment set-up.

Because of the inherent complexity and the number of different tests involved, this SOP is divided into four sections. Each section provides an overview of the objective of the test and a brief description of the methods to be used. The set-up procedures are cumulative; each phase of the aquifer test uses equipment or procedures that were used in the previous phase of the test. The reader is encouraged to read the entire SOP before beginning any onsite activities.

#### Preliminary Procedures

##### Materials:

Field notebook

Laptop computer with appropriate ports and adapters

Vented pressure transducer with internal or external data loggers

Barometric pressure monitoring equipment

Electronic water level meter or oil/water interface probe (if necessary)

Photoionization detector (PID)

Groundwater extraction pump and appropriate tubing

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Power supply  
Water storage tank  
Flow meter(s) and/or flow gauge(s)  
Stopwatch  
Small (1 to 5 gallon) container with known capacity  
Nitrile gloves  
Heat resistant gloves  
Tape measure  
Exacto, pocket knife, or scissors  
Pump lift line (polypropylene rope or other suitable material)  
Duct tape  
Indelible marker or metal file  
Paper towels  
5-gallon bucket(s)  
Distilled water (decontamination of downhole equipment)  
Plastic sheeting  
Waste labels (if necessary)

1. Review site Health and Safety Plan (HASP) before mobilizing to the field. Discuss groundwater contamination constituents and specific HASP issues with Project Manager and determine the proper level of PPE.
2. Prepare field book (SOP No. 1) daily with site description, weather conditions, participants, and other relevant observations, including all data necessary to complete the hydraulic conductivity tests. Pay careful attention to the weather conditions (e.g., changes in temperature, precipitation, wind, etc.) both locally and regionally as these can adversely affect the data.
3. Survey the ambient (background) air around the base of the well casing and wellhead for organic vapors (if appropriate) using a PID, or equivalent. Record air monitoring measurements in the field book.
4. Inspect extraction well and observation/test wells (e.g., monitoring wells or piezometers) for soundness of protective casing, surface ground seal, and locking mechanism; record findings in the field book.
5. Unlock protective casing or flush mounted curb box. Remove well cap or plug, place PID probe in wellhead, and record PID response in field book. Survey breathing zone to ensure that PPE level is appropriate.
6. Place plastic sheeting around the head of the extraction well or observation well before initiating any down well measurements or testing activities.
7. Allow static water level to equilibrate, as appropriate, before gauging the wells.

8. Measure the inside diameter (ID) of the casing and record in inches. From the top of the casing, measure the depth to water (DTW) and total depth (TD) of the well (in hundredths of a foot with an electronic water level indicator and record in the field book). Water levels should be measured from the surveyor's mark at the top of the casing, or if no mark is present, from the north side of the casing. Be sure to mark a location with a metal file or indelible marker on the north side of the casing if the surveyor mark is absent and record in the field book for future reference.
9. Thoroughly decontaminate (SOP No. 17) the water level indicator cable during retrieval using distilled water and paper towels.
10. Do not create an airtight seal by replacing the well caps at the locations that will be used during the pumping tests. It is important that they be open to the atmosphere. Take steps, if necessary, to protect the openings by loosely covering the well opening with the protective steel cover or other material to prevent rain, snow, or debris from entering the well during the test.

### Background Monitoring Test

This portion of the aquifer test involves monitoring each of the wells (pumping and observation wells) selected for the aquifer test for a period of time, usually a minimum of 24 hours, to identify any naturally-occurring (e.g., changes in barometric pressure, earth tides, rain events, etc.) or man-made (e.g., artificial recharge, nearby pumping wells, trains, etc.) forces that might systematically alter or potentially mask water level changes during the pumping portions of the aquifer test. Data collected from the background monitoring phase establishes a baseline that can be used to correct the pumping test data by analytically removing the non-pumping trends. Background data can also be used to help determine if the water-bearing unit is confined or unconfined.

The physical placement of the downhole equipment for this portion of the test will be used for the remaining phases of the aquifer test.

1. Assemble all of the monitoring gear (transducers, data loggers, cables, etc.). Verify the transducers have power (for transducers with onboard loggers) and sufficient cable length to reach the intended monitoring zone. Each cable should be fitted with a desiccant cartridge (provided by equipment supplier) to prevent moisture from building up in the transducer vent line. Also, verify that the transducers are rated for the intended water depths; Table 1 provides the criteria for selecting the appropriate transducer. Transducers with the lowest pressure rating appropriate for the anticipated depths should be selected as the device accuracy decreases as the pressure rating increases.

Table 1

Maximum Depth Below Water Table for Pressure Transducer (a)

Pressure Transducer (PSI)	Depth Below Water Table (feet)
10	23
20	46
30	69
50	115

a/ PSI=pounds per square inch

- 
2. Mark each transducer (on the sonde itself) with the well identification number to avoid confusion during data recovery after all phases of the aquifer test have been completed.
  3. Familiarize yourself with the data logging software. Transducers with onboard data loggers usually require an interface with a laptop or a hand-held computer running the appropriate proprietary software. Additional cables or adapters (e.g., RS-232 [serial] to Universal Serial Bus [USB]) may be necessary to physically link the computer to the data loggers.
  4. Thoroughly decontaminate the pressure transducers using a non-phosphate detergent and distilled water before placement of equipment into the extraction well or observation wells. Decontaminated equipment should be placed on or wrapped in clean plastic sheeting until inserted into the monitoring well or piezometer.
  5. Determine the depth below ground surface at which you will be setting the individual transducers for the pumping and observations wells:
    - a. The most critical placement will be the transducer installed in the pumping well. This transducer is typically positioned below the pump (which will be installed in the next phase of the aquifer test) to allow water level measurements during periods of significant drawdown. If the well is shallow enough and the depth rating of the transducer is sufficient to withstand the pressure (Table 1), the transducer can simply be lowered to a depth just above the bottom of the well; take care to not allow the transducer to contact the bottom of the well during installation. If the transducer is to be positioned below the pump and above the bottom of the well, measure the length from the transducer bottom up the cable and mark the cable for easy reference when lowering into the well. In either case, be sure the transducer position is such that the bottom of the pump will not contact the top of the transducer.
    - b. The placement of transducers in the observation wells is less critical. The units need only be positioned below the level of expected drawdown in each well (you should have some idea of this based on your site characterization and aquifer test design). As with the pumping well transducer placement, the easiest positioning is to place the transducer at a depth just above the bottom of the observation well (see Table 1).
  6. Practice defining, running, stopping, and downloading data using the laptop or hand-held computer before installing any of the transducers in the pumping or observation wells. Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand held computer are synchronized before programming any tests. This step is critical to ensuring a simultaneous start (and stop) of the test, contemporaneous data collection, and synchronized data logs.
  7. Follow manufacturer's specifications to prepare the barometric monitoring equipment. The unit should be placed in the same general area as the pumping well.
  8. Program the background monitoring test into each data logger and the barometric pressure monitoring equipment. The background monitoring data is recorded on a linear time scale (e.g., once every 15 minutes). As barometric pressure, tides, and other natural forces typically yield changes in the wells that occur over the space of 1 to 2 hours, data collected on a schedule of once every 15 to 30 minutes should provide a data set that is sufficiently dense to follow any systematic trends. Water levels that can change on more rapid scales (e.g., karst terrain) may require shorter sampling intervals. Check the aquifer test plan to verify the appropriate timing.

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9. Secure the transducer cable to the wellhead, protective casing, or curb box using duct tape, “S-hooks”, or other appropriate methods. The transducers should be secured so that they do not move vertically within the water column during the aquifer tests. Be careful not to pinch or kink the cable, which could block the transducer’s vent to the atmosphere.
  10. Allow the groundwater elevation in the test wells to re-equilibrate with the surrounding formation after the insertion of the transducers. The amount of time required for this step will be dictated by the characteristics of the formation. Wells with recovery times of less than a minute should be allowed to stand a minimum of fifteen minutes before initiating the background test.
  11. Run the background monitoring test for a minimum of 24 hours. Do not disturb the pumping or observation wells during the monitoring period. Be sure to record any changes in the weather, especially rain or snow events, and any other environmental or physical changes (e.g., tides, train schedules, etc.) that may potentially alter the water levels in the wells. Aquifer tests conducted in karst terrain should also note regional precipitation events (i.e., within a 20 mile radius) because even distant meteoric water can quickly be transmitted over long distances through infiltration in karstic terrain.
  12. Do not stop the barometric data monitoring equipment at the end of the background monitoring test. Barometric data should be collected for all phases of the aquifer test.
  13. Download the groundwater and barometric pressure data to the laptop or hand-held device and create a back-up copy of the data. It is not necessary to erase the data loggers, as most contain sufficient memory to store millions of data points; leaving data on the loggers provides a secondary back-up system. Verify that all of the data has been transferred to the laptop or another storage media (e.g., compact discs) before erasing the data files from the loggers.

### **Stepped-Rate Pumping Test**

The stepped-rate, or variable-rate, pumping test is designed to stress the aquifer with a series of short-term pumping periods with incrementally higher pumping rates to determine the maximum sustainable pumping rate. The primary purpose of the stepped rate test is to establish the pumping parameters for a constant-rate test; however, data from the stepped-rate tests can be used, if sufficient data is collected, as support for the constant-rate analysis. The stepped-rate test usually involves a minimum of three pumping periods or “steps” to establish the response of the aquifer.

The following procedures assume that the background monitoring test has been completed and the monitoring equipment remains in place.

1. The groundwater extraction method should be selected based on the depth to water, the anticipated flow rate, and the availability of power. Submersible pumps should incorporate a backflow check-valve(s) that prevents water within the riser pipe from flowing back into the well when the pump is shut off. Check the aquifer test design to verify the pump requirements and appropriate type of tubing.
2. Before installation, measure the length to the pumping intake depth specified in the aquifer test plan; the length includes the lift line and attached submersible pump or the length of tubing for non-submersible pumps (e.g., peristaltic pumps). Accurate measurements are critical to avoid contact with the transducers during installation and when using electric submersible pumps in low yield aquifers. Dry pumping electric submersible pumps, even for short periods of time, may damage the device.

3. Install and secure the tubing or submersible pump and tubing in the pumping well to the specified depth.
4. Attach a flow through meter to the discharge/conveyance line. Digital and optical styles are available, depending upon the predicted flow rates. Be sure to check the manufacturer's recommendations for calibration and ensure that the meter is equipped with the properly sized fittings. The flow meter measurements should be periodically verified by manually estimating the time necessary to fill a container of known capacity.
5. Extracted groundwater exiting the flow meter should be piped to a water storage tank with sufficient capacity. The tank should be constructed of materials that are compatible with contaminants that may be present in the groundwater and any applicable state or federal regulations (i.e., Department of Transportation), especially if the material will be managed as investigation-derived waste (SOP 26).
6. Define the stepped-rate tests in each data logger and the barometric pressure monitoring equipment. Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests. The stepped-rate test is a logarithmic test. Data is collected rapidly in the first portion of the test, often several times per second, with the time between successive water level measurements becoming progressively longer as the test proceeds. This approach yields dense data in the early portion of the test where changes in water levels are occurring rapidly and less data as the water levels approach a steady-state. Most data loggers will convert the logarithmic measurement schedule to a linear schedule at a pre-designated time, which can be programmed during the test set-up. Typical log-linear conversion times range from 1 to 5 minutes for the short-term (i.e., one hour or less) steps; however, the actual conversion time should be estimated based on the aquifer test design and adjusted (for the constant-rate pump phase to follow) in the field based on observations during the individual stepped-rate tests. Table 2 provides typical log-linear conversion times for various test durations.

**Table 2**

**Maximum Log-linear Conversion Times for Various Pumping Test Durations**

<u>Duration of Testing</u> (Minutes)	<u>Maximum Log-linear Conversion Time</u> (Minutes)
10-15	1
15-60	5
60-300	30
300-1440	60

1. Gauge the pumping and observation wells prior to beginning the tests to establish the groundwater elevation at static (i.e., non-pumping) conditions (need to ensure that the pumping well has re-established static conditions following insertion of the pump). These data will be used to determine the amount of drawdown during the tests. Wells should be gauged manually and using the transducers. Record the data in the field notebook.
2. Variable-rate tests typically consist of at least three pumping sessions with different pumping rates, one of which is the anticipated maximum extraction rate estimated from the existing site characterization data. Pumping strategies often begin at some fraction of the maximum anticipated rate (i.e., one-half) with increasing steps towards the maximum. An alternate strategy



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begins with the anticipated maximum pumping rate and adjusts the steps up or down based on the drawdown observed in the pumping well. In either case, it is important that at least one of the pumping sessions be conducted at a rate that is greater than the initial estimate to verify that the maximum sustainable pumping rate has been achieved.

3. Begin the variable-rate test sequence. Careful synchronization of the start of the test and the pump are critical to ensure optimal data capture during the initial drawdown phase. Begin pumping the well 0.5 to 5 seconds after the data collection has started; starting pumping before the data loggers begin collecting data will result in the loss of important early drawdown data.
4. Monitor the pumping rate and groundwater elevation frequently during the test. Pumping rates should be maintained within 5 percent of the target extraction rate. Groundwater elevations in the pumping well should be monitored regularly using both the transducer and an electronic water level meter to ensure that the well is not dewatered during the test. Record discharge rates, meter readings, and manual water level measurements in the field book.
5. Continue each step for the prescribed amount of time, or until the water level in the extraction and observation wells reach stabilization. It is important to run the initial step long enough to establish that the effects of well storage (i.e., water stored in the well casing and surrounding filter pack) have dissipated and formation water is being drawn into the well. If the water levels do not stabilize and the continued operation of the test will expose an electric submersible pump, discontinue the test and reevaluate the pumping rate.
6. Water levels should be allowed to recover to static conditions (i.e., within 95 percent of the initial elevations) between each step. Do not remove the transducers or the pump from the test wells at the end of the test.
7. Download the groundwater elevation and barometric pressure data to the laptop or hand-held device and create a back-up copy of the data. It is not necessary to erase the data from the loggers as most contain sufficient memory to store millions of data points; leaving data on the loggers also provides a secondary back-up system. Verify that all of the data has been transferred to the laptop or another storage media (e.g., compact discs) before erasing the data files from the loggers.

### **Constant-Rate Pumping Test/Recovery Test**

The constant-rate pumping phase of the aquifer test is designed to stress the water bearing zone over an extended period of time to evaluate the hydraulic conductivity and storage parameters of the unit. Typical constant-rate tests are run for 48 to 72 hours using the maximum pumping rate established during stepped-rate tests. The constant-rate test includes a recovery phase which occurs immediately after the pump is turned off. The recovery test is a passive test performed to monitor the response of the water-bearing zone as it recovers from the stress induced by the constant-rate test. Recovery is typically measured for 24 hours.

1. The set-up for the constant-rate test is identical to that of the stepped-rate tests. Groundwater levels should be at static, pre-pumping conditions before starting the constant-rate test.
2. Program the constant-rate test into the loggers and barometric pressure monitoring equipment. Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests. The constant rate test is a logarithmic test. Caution should be used when setting the conversion

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time for the test. High sampling frequencies that are important in the early phase of pumping become less desirable as the test proceeds and the water levels stabilize. Typical constant-rate tests performed in low to moderate yield unconsolidated units have conversion times that range between 15 and 60 minutes.

3. Begin the constant-rate test. Careful synchronization of the start of the test and the pump are critical to ensure optimal data capture during the initial drawdown phase. Begin pumping the well 0.5 to 5 seconds after the data collection has started; starting pumping before the data loggers begin collecting data will result in the loss of important early drawdown data.
4. Monitor the pumping rate and groundwater elevations periodically during the test. As with the stepped-rate test, pumping rates should be maintained with  $\pm 5$  percent of the target extraction rate and the water levels above the pump should be checked to ensure that the well is not being dewatered. Groundwater elevations in the pumping well should be monitored regularly using both the transducer and an electronic water level meter to ensure that the well is not dewatered during the test. Record discharge rates, meter readings, and manual water level measurements in the field book. Monitoring should be more frequent at the beginning of the test with reductions in the monitoring schedule, as appropriate. Once stabilization has been achieved, the monitoring schedule can be reduced further; however, monitoring should be conducted, at a minimum, every two hours after the water levels have stabilized to verify that the pumping rate remains constant, the water levels have not decreased due to changes in the water-bearing unit storage, and other equipment is operating as designed. Record the monitoring intervals and results in the field book.
5. Using the data recorded by the data loggers and barometric monitoring equipment, continue the constant-rate test for the prescribed amount of time or until the groundwater level in the pumping and observation wells reach stabilization.
6. At the conclusion of the constant-rate pumping test, suspend all data recording but do not shut off the pump or remove any equipment from the wells. Download the constant-rate test data from the data loggers.
7. Program a recovery test into each transducer using a laptop or hand-held device. Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests. The recovery phase is a logarithmic test. Log-linear conversion times should be the same for the recovery period as those used for the constant-rate pumping test.
8. Begin the start sequence for the recovery test. Careful synchronization of the start of the data loggers and the pump shutdown is critical for capturing the early response data that occurs as soon as the pumps are shut down (this is the inverse of the drawdown data collected during the pumping phases of the test). The pump should be shut down approximately 0.5 to 5 seconds after the data loggers begin recording the test.
9. Continue the recovery test for the prescribed amount of time or until the water level in the extraction and observation wells has returned to 95 percent of the pre pumping static water level. Do not remove the downhole equipment (e.g., pump, transducers) until the completion of the recovery test.
10. Download the groundwater elevation and barometric pressure data to the hand-held device and create a back-up copy of the data on a laptop computer at the conclusion of the recovery test. It is not necessary to erase the data from the loggers as most contain sufficient memory to store millions of data points; leaving data on the loggers also provides a secondary back-up system.



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Verify that all of the data has been transferred to the laptop or other storage media (e.g., compact discs) before erasing the data files from the data loggers.

11. Remove the pump, tubing, piping, transducer cables, and transducers from the test wells and place them on plastic sheeting around the well or in a bucket. Replace well cap, locking expandable plug, and secure test wells with locking mechanism.
12. Decontaminate transducers, transducer cables, and pump with distilled water and paper towels (SOP No. 17). Decontaminated equipment should be placed on, in, or wrapped in plastic until further use. Properly dispose of decontamination water, PPE, lift line, and other disposable supplies in accordance with the IDW plan.

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## **Standard Operating Procedures – 30**

### **In Situ Single Well Hydraulic Conductivity Test (Slug Test)**

#### **Scope:**

This standard operating procedure describes the methods and techniques to be employed for performing in situ single well hydraulic conductivity tests, or slug tests, on partially- or fully-penetrating monitoring wells or piezometers.

#### **Objective:**

The objective of performing in situ single well hydraulic conductivity tests, or slug tests, is to measure the hydraulic characteristics of the aquifer (water-bearing zone) in the immediate vicinity of the monitoring well or piezometer for aquifer characterization. The hydraulic conductivity test is performed by creating an instantaneous change in the water level by either inserting (falling head) or withdrawing (rising head) a slug from a monitoring well or piezometer that is at equilibrium.

#### **Materials:**

Field book  
Monitoring well lock keys  
Hand tools (wrenches), if necessary  
Water level indicator  
Pressure transducer-internal/external logger (Troll, PDA, or Hermit, see Table 1)  
Oil/water interface probe, if necessary  
Photoionization detector (PID), if necessary  
Closed volume slug (polyvinyl chloride [PVC] pipe filled with sand, cement, or other inert material)  
Nitrile or heat resistant gloves  
Tape measure  
Exacto, pocket knife, or scissors  
Rope  
Duct tape  
Indelible marker or metal file  
Paper towels  
5-gallon bucket(s)  
Distilled water (decontamination of downhole equipment)  
Plastic sheeting

#### **Procedures:**

1. Review site Health and Safety Plan (HASP) before mobilizing to the field. Discuss groundwater contamination constituents and specific HASP issues with Project Manager.
2. Prepare field book (SOP No. 1) with site description, weather conditions, participants, and other relevant observations, including all data necessary to complete the hydraulic conductivity tests, or slug tests. Verify monitoring well or piezometer locations.
3. With field personnel in Level D personal protective equipment (PPE), unless historical data warrants upgrading to Level C PPE, survey ambient (background) air around the base of the well casing and wellhead for organic vapors using a photoionization detector (PID) or equivalent. Record air monitoring measurements in field book.
4. Inspect monitoring well or piezometer for soundness of protective casing, surface ground seal, and locking mechanism.

5. Unlock protective casing or flush mounted curb box. Remove well cap or plug, place PID probe at wellhead, and record PID response in field book. Survey breathing zone to ensure that PPE level is appropriate. Record air monitoring measurements in the field book.
6. Place plastic sheeting around the monitoring well or piezometer head before initiating any down well measurement or testing activities. After plastic is placed around the monitoring well covering the ground surface, measurement and testing procedures may commence. If necessary, place tape on well casing to prevent cutting or slicing of rope or cable.
7. Allow static water level to equilibrate, as appropriate, before measuring or determining the presence or thickness of a floating product layer (LNAPL) or a sinking free product layer (DNAPL). Measure thickness using an oil/water interface probe, if necessary, in accordance with EPA RCRA Groundwater Monitoring Technical Enforcement Guidance Document [November 1992], state guidance, or site work plan documents (SOP No. 3a). Record observations in the field book. If LNAPL or DNAPL are present, do NOT perform hydraulic conductivity tests in the monitoring well/piezometer.
8. Measure the monitoring well or piezometer casing inside diameter (ID) and record in inches. From the top of the casing, measure the depth (in hundredths of a foot) to water (DTW) with an electronic water level indicator and record in the field book. Static water level measurements must be recorded from the surveyor's mark at the top of the casing, if present. If no mark is present, mark a location with a metal file or indelible marker on the north side of the casing and record in the field book for future reference. Measure and record the total depth (TD), in hundredths of a foot, of the monitoring well or piezometer.
9. Thoroughly decontaminate (SOP No. 17) the water level indicator cable during retrieval from the monitoring well or piezometer using distilled water and paper towels.
10. Thoroughly decontaminate the pressure transducer and closed volume slug using distilled water before placement of equipment into the monitoring well or piezometer. Decontaminated equipment should be placed on or wrapped in clean plastic sheeting until inserted into the monitoring well or piezometer. Record pertinent data logger and pressure transducer information (model or serial number and pressure transducer rating) in field book.
11. Using the tape measure, measure the length from the transducer bottom up the cable to a point where the transducer will be positioned in the monitoring well or piezometer. Mark the transducer cable at the appropriate length for reference. The transducer must be positioned at a depth below the static water level so upon total insertion of the slug into the water column (slug completely enters the water column), the slug bottom does not contact the top of the transducer.
12. Position the transducer in the monitoring well or piezometer below the static water level to the point where mark is aligned with the monitoring well or piezometer survey mark. Allow transducer to equilibrate for a minimum of 10 minutes before starting test.
13. Secure transducer cable to the wellhead, the well casing, protective casing (i.e., duct tape), or the curb box (i.e., "s" hooks). Note, the transducer must be secured such that the transducer can NOT move vertically within the water column during performance of the hydraulic conductivity tests. If using an external data logger, connect the transducer cable to the automatic data logger.
14. Power the data logger/transducer and check for proper operation and battery life. Enter monitoring well/piezometer information, transducer reference data, and testing parameters. Generate a test file for each planned individual slug test; the number of tests to be performed should be determined by the Project Manager, but should be no less than three (two falling and

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one rising) per monitoring well/piezometer. Verify that data logger/transducer collection mode is programmed to record on the logarithmic scale, with a maximum asymptotic interval of 10 minutes.

15. Evaluate water level stabilization by reviewing pressure head readings from the transducer. Once pressure readings have stabilized, record the transducer reference point (zero or reference head).
16. Verify that the slug is full and closed, as applicable. Closed volume slug should be of an appropriate diameter and length to displace an appropriate water volume on insertion into the water column. Secure rope to the top of the closed volume slug; checking knot to be certain rope will not untie during testing process. Using the tape measure, measure the length from the bottom of the closed volume slug up the rope to a point where the slug will be positioned immediately above the recorded static water level. Mark this location.
17. On the rope, mark a second depth measurement corresponding to the depth at which the slug should be lowered into the water column (falling head). The slug must be positioned below the static water level upon total insertion into the water column, but above the level of the transducer. Secure the closed volume slug rope to well head, the well casing, protective casing, or the curb box using duct tape or some other means.
18. In preparation for the first test, lower the closed volume slug into the monitoring well or piezometer so that the slug bottom is suspended immediately above the static water column. This position should correspond to the first mark (No. 16 above).
19. Falling-Head Tests  
Start the test on the data logger and, approximately 0.5 second to 1 second later, smoothly but quickly lower the closed volume slug into the water column (falling-head test, slug in) until the second mark is positioned equal to the wellhead survey mark. Be sure that the slug does not move the transducer cable.
20. Rising-Head Tests
21. Start the data logger and approximately 0.5 second to 1 second later, smoothly, but quickly, remove the closed volume slug from the water column (rising-head or bail-down test, slug out) until the first mark is positioned equal to the wellhead survey mark (ensuring that the slug is above the original static water level). Be sure that the slug does not move the transducer cable.
20. During each hydraulic conductivity test, monitor (review) the water level data collected on the data logger to ensure proper operation. Record weather changes, heavy equipment movement, or other conditions that may affect water level measurements in the field book. In addition, verification should also be conducted to determine that the volume of the slug is roughly equal to the volume of water displaced, as measured by the data logger. Using the data recorded by the data logger, continue the hydraulic conductivity test, or slug test, until the water level in the monitoring well or piezometer returns to the smaller of either 0.02-foot from the original static water level or within five percent of the change in head.
22. Using the data logger, stop collecting measurements when the static water level stabilizes as described in Step 20.
23. After completion of the testing procedures at a location, remove closed volume slug, transducer cable, and transducer from the monitoring well or piezometer and place on plastic sheeting around the well or in a bucket. Replace well cap, expandable plug, curb box top and secure monitoring well or piezometer with locking mechanism.

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24. Decontaminate transducer, transducer cable, and closed volume slug with distilled water and paper towels (SOP No. 17). Decontaminated equipment should be placed on, in, or wrapped in plastic until further use. Properly dispose of decontamination water, PPE, rope, and other disposable supplies in accordance with the investigation-derived waste (IDW) plan.
  25. In the field, periodically, and/or before concluding the field activities, download data files from the transducer/logger to a computer diskette or laptop computer.

**General Notes:**

If groundwater quality data is available for the well(s) being tested, conduct the slug tests in the order of increasing contaminant levels to reduce the potential for cross-contamination.

Single well hydraulic conductivity test, or slug test, data should be analyzed using appropriate aquifer type (unconfined, confined, etc.), method (Bouwer and Rice, Hvorslev, etc.), monitoring well or piezometer construction parameters (fully- or partially-penetrating), pre-testing water level measurements, and HydroSOLV's AQTESOLV for Windows (or equivalent) software package. Hydraulic conductivity (K) values are calculated (length/time) as centimeters per second (cm/sec), meters per second (m/sec), or feet per second (ft/sec).

Pressure transducer selection criteria:

Table 1  
Maximum Depth Below Water Level for Pressure Transducer (a)

Pressure Transducer (PSI)	Depth Below Water Table (feet)
11	23
21	46
31	69
51	115

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a/ PSI=pounds per square inch

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### **SOP Revision History**

Revised July 2012 to include new groundwater sampling SOP #3 only.

Since the boring log form was included in SOP#9 but was not referenced, a brief reference to form was added.

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## Appendix B – Hach Portable Colorimeter Procedures for Nitrate, Sulfate, and Orthophosphate

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# Methods Quick Reference Guide

The tables on the following 4 pages list test ranges, methods of analysis, and corresponding reagent set Product Numbers. The complete procedure for each test is included in the manual or CD supplied with the instrument. The ranges given are for the pre-calibrated instrument readout; higher ranges can be analyzed by sample dilution. Parameters marked "EPA" are EPA-approved, accepted, or equivalent for reporting purposes; sample pretreatment may be required on some procedures. If no reagent set is listed for a parameter, order needed reagents and supplies separately.

Test	EPA Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR1850	DR1820	PC II Colorimeter	Prod. No.
Alachlor in Water	Immunoassay	10202	0.1 - 0.5 ppb, threshold	•	•	•	•	•	•	2813000
Alkalinity, Total (TNTplus)	Colorimetric	10239	25 - 400 mg/L	•	•					TNT870
Aluminum	Aluminon	8012	0.008 - 0.800 mg/L	•	•	•	•	•	•	2242000
Aluminum	Eriochrome Cyanine R	8326	0.002 - 0.250 mg/L	•	•	•				2603700
Aluminum (TNTplus)	Chromazurol S	10215	0.02 - 0.50 mg/L	•	•					TNT848
Ammonia, Nitrogen	Salicylate	8155	0.01 - 0.50 mg/L	•	•	•	•	•	•	2668000
Ammonia, Nitrogen (TNTplus), ULR	• Salicylate	10205	0.015 - 2.000 mg/L	•	•					TNT830
Ammonia, Nitrogen	• Nessler	8038	0.02 - 2.50 mg/L	•	•	•				2458200
Ammonia, Nitrogen (Test 'N Tube), LR	Salicylate	10023	0.02 - 2.50 mg/L	•	•	•	•	•		2604545
Ammonia, Nitrogen (TNTplus), LR	• Salicylate	10205	1 - 12 mg/L	•	•					TNT831
Ammonia, Nitrogen (Test 'N Tube), HR	Salicylate	10031	0.4 - 50.0 mg/L	•	•	•	•	•		2606945
Ammonia, Nitrogen (TNTplus), HR	• Salicylate	10205	2 - 47 mg/L	•	•					TNT832
Ammonia, Free, Nitrogen	Indophenol	10200	0.01 - 0.50 mg/L	•	•	•	•	•	•	2879700
Arsenic	• Silver Diethyldithiocarbamate	8013	0.020 - 0.200 mg/L	•	•	•				—
Atrazine	Immunoassay	10050	0.5 - 3.0 ppb, threshold	•	•	•			•	2762700
Barium	Turbidimetric	8014	2 - 100 mg/L	•	•	•				1206499
Benzotriazole	UV Photolysis	8079	1.0 - 16.0 mg/L	•	•	•	•			2141299
Boron	Carmine	8015	0.2 - 14.0 mg/L	•	•	•				—
Bromine	DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	2105669
Bromine (AccuVac)	DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	2503025
Cadmium	Dithizone	8017	0.7 - 80.0 µg/L	•	•	•				2242200
Cadmium (TNTplus) <sup>1</sup>	Cadion	10217	0.02 - 0.30 mg/L	•	•					TNT852
Carbohydrazide	Iron Reduction	8140	5 - 600 µg/L	•	•	•	•			2446600
Chloramine, Mono, LR	Indophenol	10171 10200	0.04 - 4.50 mg/L	•	•	•	•	•	•	2802246
Chloramine, Mono (Test 'N Tube), HR	Indophenol	10172	0.1 - 10.0 mg/L	•	•	•				2805145
Chloride	Mercuric Thiocyanate	8113	0.1 - 25.0 mg/L	•	•	•				2319800
Chlorine, Free	Indophenol	10241	0.04 - 4.50 mg/L	•	•	•	•	•	•	—
Chlorine, Free	• DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	2105569
Chlorine, Free (AccuVac)	• DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	2502025
Chlorine, Free (Pour-Thru Cell)	DPD Rapid Liquid	10059	0.02 - 2.00 mg/L	•	•	•				2556900
Chlorine, Free (TNTplus)	• DPD	10231	0.05 - 2.00 mg/L	•	•					TNT866
Chlorine, Free (Test 'N Tube)	DPD	10102	0.09 - 5.00 mg/L	•	•	•	•	•	•	2105545
Chlorine, Free, MR	• DPD	10245	0.05 - 4.00 mg/L	•	•	•	•	•	•	1407099
Chlorine, Free, HR	• DPD	10069	0.1 - 10.0 mg/L	•	•	•	•	•	•	1407099
Chlorine, Free & Total (TNTplus)	• DPD	10232	0.05 - 2.00 mg/L	•	•					TNT866T
Chlorine, Total (Pour-Thru Cell), ULR	• DPD	8370 10014	2 - 500 µg/L	•	•	•				2563000
Chlorine, Total	• DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	2105669
Chlorine, Total (AccuVac)	• DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	2503025
Chlorine, Total (Pour-Thru Cell)	DPD Rapid Liquid	10060	0.02 - 2.00 mg/L	•	•	•				2557000
Chlorine, Total (Test 'N Tube)	DPD	10101	0.09 - 5.00 mg/L	•	•	•	•	•	•	2105645
Chlorine, Total, MR	• DPD	10250	0.05 - 4.00 mg/L	•	•	•	•	•	•	1406499
Chlorine, Total, HR	• DPD	10070	0.1 - 10.0 mg/L	•	•	•	•	•	•	1406499
Chlorine Demand/Requirement	• DPD	10223	Multiple Ranges	•	•	•	•	•	•	—
Chlorine Dioxide, DPD	• DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	2770900
Chlorine Dioxide, DPD (AccuVac)	• DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	2771000
Chlorine Dioxide (Europe Only)	Amaranth		20 - 500 µg/L	•	•	•				—
Chlorine Dioxide, LR	Chlorophenol Red	8065	0.01 - 1.00 mg/L	•	•	•				2242300
Chlorine Dioxide, MR	Direct Reading	8345	1 - 50 mg/L	•	•	•	•			—
Chlorine Dioxide, HR	Direct Reading	8138	5 - 1000 mg/L	•	•	•				—

<sup>1</sup>As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.

# Methods Quick Reference Guide

Test	EPA Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR1890	DR1850	DR1820	PC II Colorimeter	Prod. No.
Chromium, Hexavalent	• 1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•	•	•	•	1271099
Chromium, Hexavalent (AccuVac)	• 1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•	•	•	•	2505025
Chromium, Hexavalent and Total (TNTplus)	• <sup>1</sup> 1,5 Diphenylcarbohydrazide	10218 10219	0.03 - 1.00 mg/L	•	•	•	•	•	•	•	TNT854
Chromium, Total	Alkaline Hypobromite Oxidation	8024	0.01 - 0.70 mg/L	•	•	•	•	•	•	•	2242500
Cobalt	PAN	8078	0.01 - 2.00 mg/L	•	•	•	•	•	•	•	2651600
COD, ULR	Dichromate	8000	0.7 - 40.0 mg/L	•	•	•	•	•	•	•	2415825
COD, LR	• Dichromate	8000	3 - 150 mg/L	•	•	•	•	•	•	•	2125825
COD, HR	• Dichromate	8000	20 - 1,500 mg/L	•	•	•	•	•	•	•	2125925
COD, HR+	Dichromate	8000	200 - 15,000 mg/L	•	•	•	•	•	•	•	2415925
COD	Manganese III	10067	30 - 1000 mg/L	•	•	•	•	•	•	•	2623425
COD, Mercury-Free (TNTplus), HR	Dichromate	10236	25 - 100 mg/L	•	•	•	•	•	•	•	TNT825
COD (TNTplus), ULR	Dichromate	10211	1 - 60 mg/L	•	•	•	•	•	•	•	TNT820
COD (TNTplus), LR	• Dichromate	8000	3 - 150 mg/L	•	•	•	•	•	•	•	TNT821
COD (TNTplus), HR	• Dichromate	8000	20 - 1500 mg/L	•	•	•	•	•	•	•	TNT822
COD (TNTplus), UHR	Dichromate	10212	250 - 15,000 mg/L	•	•	•	•	•	•	•	TNT823
Color	ADMI Weighted Ordinate	10048	3 - 250 units	•	•	•	•	•	•	•	—
Color, True and Apparent	Platinum-Cobalt	8025	15 - 500 units	•	•	•	•	•	•	•	—
Color, True and Apparent, LR	Platinum-Cobalt	8025	3 - 200 units	•	•	•	•	•	•	•	—
Copper, LR	Porphyrin	8143	1 - 210 µg/L	•	•	•	•	•	•	•	2603300
Copper	• Bicinchoninate	8506	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	2105869
Copper (AccuVac)	Bicinchoninate	8026	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	2504025
Copper (TNTplus) <sup>2</sup>	Bathocuproine	10238	0.1 - 8.0 mg/L	•	•	•	•	•	•	•	TNT860
Cyanide	Pyridine-Pyrazalone	8027	0.002 - 0.240 mg/L	•	•	•	•	•	•	•	2430200
Cyanuric Acid	Turbidimetric	8139	5 - 50 mg/L	•	•	•	•	•	•	•	246066
DEHA (Diethylhydroxylamine)	Iron Reduction	8140	3 - 450 µg/L	•	•	•	•	•	•	•	2446600
Detergents (Surfactants)	Crystal Violet	8028	0.002 - 0.275 mg/L	•	•	•	•	•	•	•	2446800
Dissolved Oxygen (AccuVac), LR	Indigo Carmine	8316	6 - 800 µg/L	•	•	•	•	•	•	•	2501025
Dissolved Oxygen (AccuVac), HR	HRDO	8166	0.3 - 15.0 mg/L	•	•	•	•	•	•	•	2515025
Dissolved Oxygen (AccuVac), UHR	Ultra High Range	8333	1.0 - 40.0 mg/L	•	•	•	•	•	•	•	2515025
Erythorbic Acid (Isoascorbic Acid)	Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•	•	•	•	2446600
Fluoride, Arsenic Free	• <sup>3,4</sup> SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	2947549
Fluoride, Arsenic Free (AccuVac)	• <sup>3,4</sup> SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	2527025
Fluoride	• <sup>4</sup> SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	44449
Fluoride (AccuVac)	• <sup>4</sup> SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	2506025
Formaldehyde	MBTH	8110	3 - 500 µg/L	•	•	•	•	•	•	•	2257700
Hardness, Total, ULR	Chlorophosphonazo Colorimetric	8374	8 - 1000 µg/L	•	•	•	•	•	•	•	2603100
Hardness, Total, ULR (Pour-Thru Cell)	Chlorophosphonazo Rapid Liquid	8374	4 - 1000 µg/L	•	•	•	•	•	•	•	—
Hardness, Ca & Mg	Calmagite Colorimetric	8030	0.05 - 4.00 mg/L	•	•	•	•	•	•	•	2319900
Hydrazine	p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•	•	•	•	179032
Hydrazine (AccuVac)	p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•	•	•	•	2524025
Hydroquinone	Iron Reduction	8140	9 - 1000 µg/L	•	•	•	•	•	•	•	2446600
Iodine DPD	DPD	8031	0.07 - 7.00 mg/L	•	•	•	•	•	•	•	2105669
Iodine DPD (AccuVac)	DPD	8031	0.07 - 7.00 mg/L	•	•	•	•	•	•	•	2503025
Iron (TNTplus) <sup>2</sup>	• Phenanthroline	10229	0.2 - 6.0 mg/L	•	•	•	•	•	•	•	TNT858
Iron	FerroZine	8147	0.009 - 1.400 mg/L	•	•	•	•	•	•	•	230166
Iron (Pour-Thru Cell)	FerroZine Rapid Liquid	8147	0.009 - 1.400 mg/L	•	•	•	•	•	•	•	230149
Iron, Ferrous	1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	103769
Iron, Ferrous (AccuVac)	1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	2514025
Iron, Total	FerroMo	8365	0.01 - 1.80 mg/L	•	•	•	•	•	•	•	2544800
Iron, Total	TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•	•	•	2608799
Iron, Total (AccuVac)	TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•	•	•	2510025
Iron, Total	• FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	2105769

<sup>1</sup>EPA approved for Cr<sup>6+</sup> only. <sup>2</sup>As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.

<sup>3</sup>Per 40 CFR 136.6 Method Modification and Flexibility. <sup>4</sup>Not EPA accepted for drinking water using DR/800 Series colorimeters.

# Methods Quick Reference Guide

Test	EPA Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR 1890	DR 1820	PC II Colorimeter	Prod. No.
Iron, Total (AccuVac)	• FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	2507025
Isoascorbic Acid (Erythorbic Acid) (ISA)	Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•			2446600
Lead	LeadTrak Fast Column Extraction 8317	8317	5 - 150 µg/L	•	•	•				2375000
Lead	• Dithizone	8033	3 - 300 µg/L	•	•	•				2243100
Lead (TNTplus)*	PAR	10216	0.1 - 2.0 mg/L	•	•					TNT850
Manganese, LR	PAN	8149	0.006 - 0.700 mg/L	•	•	•	•		•	2651700
Manganese, HR	• Periodate Oxidation	8034	0.1 - 20.0 mg/L	•	•	•	•	•	•	2430000
Mercury	Cold Vapor Mercury Concentration	10065	0.1 - 2.5 µg/L	•	•	•				2658300
Methylethylketoxime (MEKO)	Iron Reduction	8140	15 - 1000 µg/L	•	•	•	•			2446600
Molybdenum, Molybdate, LR	Ternary Complex	8169	0.02 - 3.00 mg/L	•	•	•	•		•	2449400
Molybdenum, Molybdate, HR	Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•			2604100
Molybdenum, Molybdate (AccuVac), HR	Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•			—
Nickel	PAN	8150	0.006 - 1.000 mg/L	•	•	•	3		•	2651600
Nickel	• Heptoxime	8037	0.02 - 1.80 mg/L	•	•	•				2243500
Nickel (TNTplus) <sup>1</sup>	Dimethylglyoxime	10220	0.1 - 6.0 mg/L	•	•					TNT856
Nitrate, Nitrogen, LR	Cadmium Reduction	8192	0.01 - 0.50 mg/L	•	•	•	•	•	•	2429800
Nitrate, Nitrogen (TNTplus), LR	Dimethylphenol	10206	0.23 - 13.5 mg/L	•	•					TNT835
Nitrate, Nitrogen, MR	Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•			2106169
Nitrate, Nitrogen (AccuVac), MR	Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•			2511025
Nitrate, Nitrogen	UV Screening	10049	0.1 - 10.0 mg/L	•						—
Nitrate, Nitrogen (Test 'N Tube), HR	Chromotropic Acid	10020	0.2 - 30.0 mg/L	•	•	•	•			2605345
Nitrate, Nitrogen, HR	Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	2106169
Nitrate, Nitrogen (AccuVac), HR	Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	2511025
Nitrate, Nitrogen (TNTplus), HR	Dimethylphenol	10206	5 - 35 mg/L	•	•					TNT836
Nitrite, Nitrogen, LR	• Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•	2107169
Nitrite, Nitrogen (AccuVac), LR	• Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•	2512025
Nitrite, Nitrogen (Test 'N Tube), LR	Diazotization	10019	0.003 - 0.500 mg/L	•	•	•	•	•	•	2608345
Nitrite, Nitrogen (TNTplus), LR	• Diazotization	10207	0.015 - 0.600 mg/L	•	•					TNT839
Nitrite, Nitrogen (TNTplus), HR	Diazotization	10237	0.6 - 6.0 mg/L	•	•					TNT840
Nitrite, Nitrogen, HR	Ferrous Sulfate	8153	2 - 250 mg/L	•	•	•	•			2107569
Nitrogen, Ammonia (see Ammonia, Nitrogen)										
Nitrogen, Total (Test 'N Tube), LR	Persulfate Digestion	10071	0.5 - 25.0 mg/L	•	•	•	•			2672245
Nitrogen, Total (TNTplus), LR	Persulfate Digestion	10208	1 - 16 mg/L	•	•					TNT826
Nitrogen, Total (TNTplus), HR	Persulfate Digestion	10208	5 - 40 mg/L	•	•					TNT827
Nitrogen, Total (Test 'N Tube), HR	Persulfate Digestion	10072	2 - 150 mg/L	•	•	•	•			2714100
Nitrogen, Total (TNTplus), UHR	Persulfate Digestion	10208	20 - 100 mg/L	•	•					TNT828
Nitrogen, Total Inorganic (TIN) (Test 'N Tube)	Titanium Trichloride Reduction	10021	0.2 - 25.0 mg/L	•	•	•	•	•		2604945
Nitrogen, Simplified TKN (TNTplus)	s-TKN	10242	0 - 16 mg/L	•	•					TNT880
Nitrogen, Total Kjeldahl (TKN)	Nessler	8075	1 - 150 mg/L	•	•	•	•			2495300
Organic Carbon, Total (See TOC)										—
Organic Constituents, UV-Absorbing (UV-254)	Direct Reading	10054	Varies-Units Abs/cm	•						—
Oxygen Demand, Chemical (See COD)										—
Oxygen, Dissolved (See Dissolved Oxygen)										—
Oxygen Scavengers (See specific compounds)										—
Ozone (AccuVac), LR	Indigo	8311	0.01 - 0.25 mg/L	•	•	•	•	•	•	2516025
Ozone (AccuVac), MR	Indigo	8311	0.01 - 0.75 mg/L	•	•	•	•	•	•	2517025
Ozone (AccuVac), HR	Indigo	8311	0.01 - 1.50 mg/L	•	•	•	•	•	•	2518025
PCB (Polychlorinated Biphenyls) in Soil <sup>2</sup>	Immunoassay	10050	1 - 50 ppm, threshold	•	•	•			•	2773500
pH	Colorimetric Phenol Red	10076	6.5 - 8.5 units			•	•	•	•	2657512
Phenols	• 4-Aminoantipyrine	8047	0.002 - 0.200 mg/L	•	•	•				2243900

<sup>1</sup>As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal. <sup>2</sup>Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II). <sup>3</sup>Nickel PAN method reagent set for DR/890 is Prod. No. 2242600

# Methods Quick Reference Guide

Test	EPA Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR1890	DR1850	DR1820	PC II Colorimeter	Prod. No.
Phosphonates	Persulfate UV Oxidation	8007	0.02 - 125.0 mg/L	•	•	•	•	•	•	•	2429700
Phosphorus, Reactive	• PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•	•	•	2106069
Phosphorus, Reactive (AccuVac)	• PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•	•	•	2508025
Phosphorus, Reactive (Test 'N Tube)	• PhosVer 3	8048	0.06 - 5.00 mg/L	•	•	•	•	•	•	•	2742545
Phosphorus, Reactive	Amino Acid	8178	0.23 - 30.00 mg/L	•	•	•	•	•	•	•	2244100
Phosphorus, Reactive	Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•	•	•	•	2076032
Phosphorus, Reactive (AccuVac)	Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•	•	•	•	2525025
Phosphorus, Reactive (Test 'N Tube), HR	Molybdovanadate	8114	1.0 - 100.0 mg/L	•	•	•	•	•	•	•	2767345
Phosphorus, Reactive (Pour-Thru Cell), HR	Molybdovanadate Rapid Liquid	8114	0.3 - 45.0 mg/L	•	•	•	•	•	•	•	2076049
Phosphorus, Reactive (Pour-Thru Cell), LR	• Ascorbic Acid Rapid Liquid	10055	19 - 3000 µg/L	•	•	•	•	•	•	•	2678600
Phosphorus, Reactive (TNTplus)	Molybdovanadate	10214	5.0 - 90.0 mg/L	•	•	•	•	•	•	•	TNT846
Phosphorus, Acid Hydrolyzable (Test 'N Tube)	PhosVer 3 with Acid Hydrolysis	8180	0.06 - 3.50 mg/L	•	•	•	•	•	•	•	2742645
Phosphorus, Total (Test 'N Tube)	• PhosVer 3 with Acid Persulfate Digestion	8190	0.06 - 3.50 mg/L	•	•	•	•	•	•	•	2742645
Phosphorus, Total (Test 'N Tube), HR	Molybdovanadate with Acid Persulfate Digestion	10127	1.0 - 100.0 mg/L	•	•	•	•	•	•	•	2767245
Phosphorus, Reactive and Total (TNTplus), LR	• Ascorbic Acid	10209 10210	0.15 - 4.50 mg/L	•	•	•	•	•	•	•	TNT843
Phosphorus, Reactive and Total (TNTplus), HR	• Ascorbic Acid	10209 10210	1.5 - 15.0 mg/L	•	•	•	•	•	•	•	TNT844
Phosphorus, Reactive and Total (TNTplus), UHR	• Ascorbic Acid	10209 10210	6 - 60 mg/L	•	•	•	•	•	•	•	TNT845
Potassium	Tetraphenylborate	8049	0.1 - 7.0 mg/L	•	•	•	•	•	•	•	2459100
Quaternary Ammonium Compounds	Direct Binary Complex	8337	0.2 - 5.0 mg/L	•	•	•	•	•	•	•	2459200
Selenium	Diaminobenzidine	8194	0.01 - 1.00 mg/L	•	•	•	•	•	•	•	2244200
Silica (Pour-Thru Cell), ULR	Heteropoly Blue	8282	3 - 1000 µg/L	•	•	•	•	•	•	•	2553500
Silica (Pour-Thru Cell), ULR	Heteropoly Blue Rapid Liquid	8282	3 - 1000 µg/L	•	•	•	•	•	•	•	2678500
Silica, LR	Heteropoly Blue	8186	0.010 - 1.600 mg/L	•	•	•	•	•	•	•	2459300
Silica, HR	Silicomolybdate	8185	1 - 100 mg/L	•	•	•	•	•	•	•	2429600
Silver	Colorimetric	8120	0.02 - 0.70 mg/L	•	•	•	•	•	•	•	2296600
Sulfate	• SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	2106769
Sulfate (AccuVac)	• SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	2509025
Sulfate (TNTplus), LR	Turbidimetric	10227	40 - 150 mg/L	•	•	•	•	•	•	•	TNT864
Sulfate (TNTplus), HR	Turbidimetric	10227	150 - 900 mg/L	•	•	•	•	•	•	•	TNT865
Sulfide	• Methylene Blue	8131	5 - 800 µg/L	•	•	•	•	•	•	•	2244500
Sulfite (Europe only)	Colorimetric		0.10 - 5.00 mg/L	•	•	•	•	•	•	•	—
Surfactants (See Detergents)				•	•	•	•	•	•	•	—
Suspended Solids	Photometric	8006	5 - 750 mg/L	•	•	•	•	•	•	•	—
Tannin & Lignin	Tyrosine	8193	0.1 - 9.0 mg/L	•	•	•	•	•	•	•	2244600
TOC (Total Organic Carbon), LR	Direct Method	10129	0.3 - 20.0 mg/L	•	•	•	•	•	•	•	2760345
TOC (Total Organic Carbon), MR	Direct Method	10173	15 - 150 mg/L	•	•	•	•	•	•	•	2815945
TOC (Total Organic Carbon), HR	Direct Method	10128	100 - 700 mg/L	•	•	•	•	•	•	•	2760445
Tolytriazole	UV Photolysis	8079	1.0 - 20.0 mg/L	•	•	•	•	•	•	•	2141299
Toxicity	ToxTrak	10017	0 - 100 % inhibition	•	•	•	•	•	•	•	2597200
TPH in Soil <sup>1</sup>	Immunoassay	10050	2 - 20 ppm, threshold	•	•	•	•	•	•	•	2774300
TPH in Water	Immunoassay	10050	2 - 20 ppm, threshold	•	•	•	•	•	•	•	2774300
Trihalomethanes (THM)	THM Plus	10132	10 - 600 µg/L	•	•	•	•	•	•	•	2790800
Trihalomethane Formation Potential (THMFP)	THM Plus	10224	10 - 600 µg/L	•	•	•	•	•	•	•	2790800
Volatile Acids	Esterification	8196	27 - 2800 mg/L	•	•	•	•	•	•	•	2244700
Volatile Acids (TNTplus)	Esterification	10240	50 - 2500 mg/L	•	•	•	•	•	•	•	TNT872
Zinc	• Zincon	8009	0.01 - 3.00 mg/L	•	•	•	•	•	•	•	2429300

<sup>1</sup>Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II).

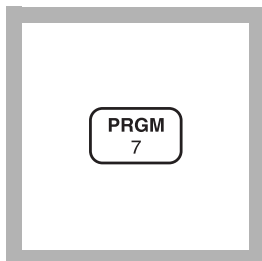
For more information or to place an order, call 800-227-4224 or visit: [www.hach.com](http://www.hach.com)

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# NITRATE, High Range (0 to 30.0 mg/L $\text{NO}_3^-$ -N) For water, wastewater, and seawater\*

## Cadmium Reduction Method (Using Powder Pillows or AccuVac Ampuls)

### Using Powder Pillows



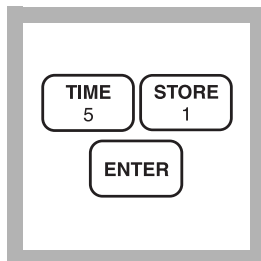
1. Enter the stored program number for high range nitrate nitrogen ( $\text{NO}_3^-$ -N) powder pillows.

Press: **PRGM**

The display will show:

**PRGM ?**

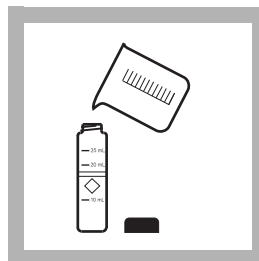
*Note: For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



2. Press: **51 ENTER**

The display will show **mg/L,  $\text{NO}_3$ -N** and the **ZERO** icon.

*Note: For alternate forms ( $\text{NO}_3$ ), press the **CONC** key.*



3. Fill a sample cell with 10 mL of sample.

*Note: Adjust the pH of stored samples before analysis.*

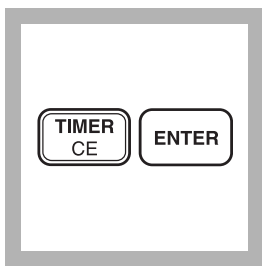


4. Add the contents of one NitraVer 5 Nitrate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the sample cell.

*Note: It is important to remove all of the powder from the foil pillow. Tap the pillow until no more powder pours out.*

\* Seawater requires a manual calibration; see Interferences.

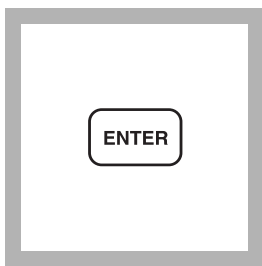
## NITRATE, High Range, continued



5. Press:  
**TIMER ENTER**

A one-minute reaction period will begin. Shake the sample cell vigorously until the timer beeps.

***Note:** It is important to shake the cell vigorously. Shaking time and technique influence color development. For most accurate results, do successive tests on a standard solution and adjust the shaking time to obtain the correct result.*



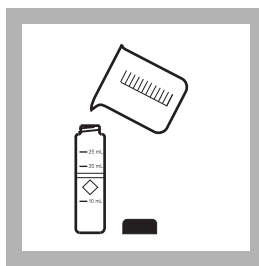
6. After the timer beeps, the display will show:  
**5:00 TIMER 2**

Press: **ENTER**

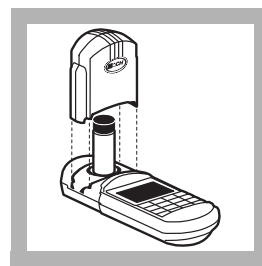
A five-minute reaction period will begin.

***Note:** A deposit will remain after the reagent dissolves and will not affect test results.*

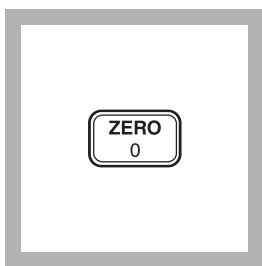
***Note:** An amber color will develop if nitrate nitrogen is present.*



7. Fill another cell with 10 mL of sample (the blank). Wipe off any fingerprints or liquid.



8. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

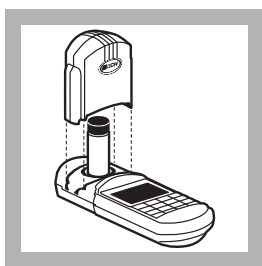


9. When the timer beeps, press **ZERO**.

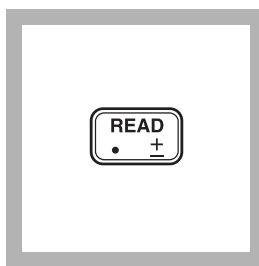
The cursor will move to the right, then the display will show:

**0.0 mg/L NO<sub>3</sub>-N**

***Note:** If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



10. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



11. Press: **READ**

The cursor will move to the right, then the result in mg/L NO<sub>3</sub>-N (or alternate form) will be displayed.

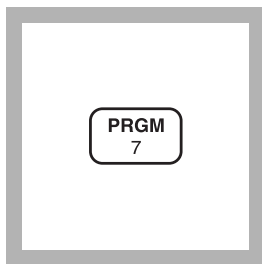
***Note:** Use of the Standard Adjust feature for each new lot of reagent is highly recommended. See Accuracy Check.*

***Note:** Rinse the sample cell immediately after use to remove all cadmium particles. Save the spent sample for proper hazardous waste disposal for cadmium.*



# NITRATE, High Range, continued

## Using AccuVac Ampuls



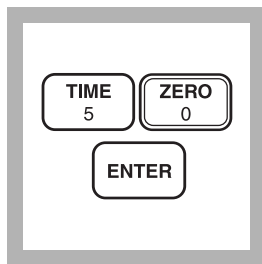
**1.** Enter the stored program number for high range nitrate nitrogen ( $\text{NO}_3^- - \text{N}$ ) AccuVac Ampuls.

Press: **PRGM**

The display will show:

**PRGM ?**

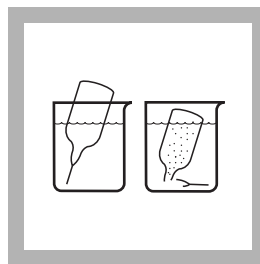
***Note:** For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



**2.** Press: **50 ENTER**

The display will show **mg/L,  $\text{NO}_3 - \text{N}$**  and the **ZERO** icon.

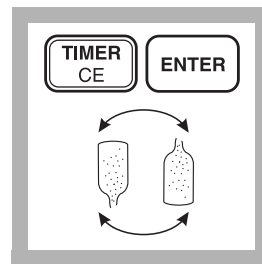
***Note:** For alternate forms ( $\text{NO}_3$ ), press the **CONC** key.*



**3.** Collect at least 40 mL of sample in a 50-mL beaker. Fill a NitraVer 5 Nitrate AccuVac Ampul with sample. Place a stopper over the tip of the ampul.

***Note:** Keep the tip immersed while the ampul fills. The ampul will not fill completely.*

***Note:** Adjust the pH of stored samples before analysis.*

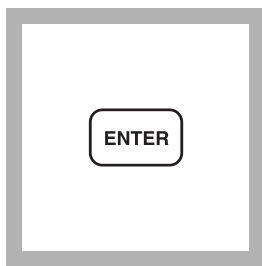


**4.** Press:

**TIMER ENTER**

A one-minute mixing period will begin. Invert the ampul repeatedly back and forth until the timer beeps. Wipe off any liquid or fingerprints.

***Note:** Mixing time and technique influence color development. For most accurate results, do successive tests on a standard solution and adjust the mixing time to obtain the correct result.*



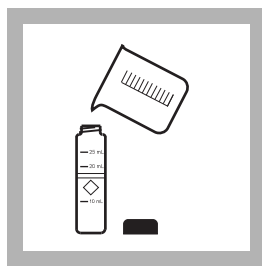
**5.** The display will show: **5:00 TIMER 2**

Press: **ENTER**

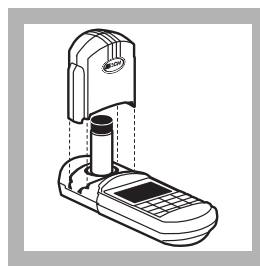
A five-minute reaction period will begin.

***Note:** A deposit will remain after the reagent dissolves and will not affect results.*

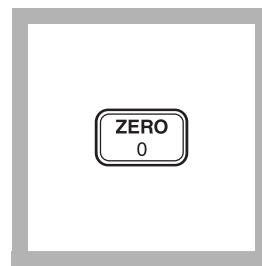
***Note:** An amber color will develop if nitrate nitrogen is present.*



**6.** Fill a sample cell with at least 10 mL of sample (the blank).



**7.** When the timer beeps, place the blank in the cell holder. Tightly cover the sample cell with the instrument cap.



**8.** Press: **ZERO**

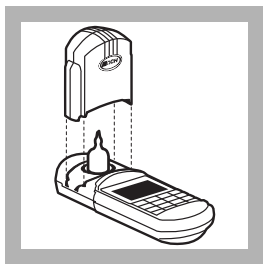
The cursor will move to the right, then the display will show:

**0.0 mg/L  $\text{NO}_3 - \text{N}$**

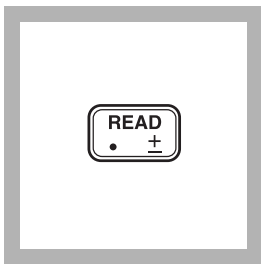
***Note:** If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*

## NITRATE, High Range, continued

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**9.** Place the AccuVac Ampul into the cell holder. Tightly cover the ampul with the instrument cap.



**10.** Press: **READ**

The cursor will move to the right, then the result in mg/L  $\text{NO}_3\text{-N}$  (or alternate form) will be displayed.

***Note:** Use of the Standard Adjust feature for each new lot of reagent is highly recommended. See Accuracy Check.*

***Note:** See Pollution Prevention and Waste Management for proper disposal of cadmium.*

---

## Sampling and Storage

Collect samples in clean plastic or glass bottles. Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods, adjust sample pH to 2 or less with sulfuric acid, ACS (about 2 mL per liter). Sample refrigeration is still required.

Before testing the stored sample, warm to room temperature and neutralize with 5.0 N Sodium Hydroxide Standard Solution.

Do not use mercury compounds as preservatives.

Correct the test result for volume additions; see *Correction for Volume Additions (Section 1)* for more information.



## Accuracy Check

### Standard Additions Method

- a) Fill three 25-mL mixing cylinders with 25 mL of sample.
- b) Snap the neck off a Nitrate Nitrogen Ampule Standard, 500 mg/L nitrate nitrogen.
- c) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of Nitrate Nitrogen Standard Solution to the three samples. Stopper and mix thoroughly.
- d) For AccuVac analysis, transfer the solutions to clean, dry 50-mL beakers. For analysis with powder pillows, transfer only 10 mL of solution to clean, dry sample cells.
- e) Analyze each sample as described above. The nitrate nitrogen ( $\text{NO}_3^-$ -N) concentration should increase 2.0 mg/L for each 0.1 mL of standard added.
- f) If these increases do not occur, see *Standard Additions (Section 1)* for more information.

### Standard Solution Method

Use a Hach Nitrate-Nitrogen Standard Solution, 10.0 mg/L  $\text{NO}_3^-$ -N, listed under Optional Reagents as the sample and perform the procedure as described above.

### Standard Adjust

To adjust the calibration curve using the reading obtained with the 10.0-mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **10.0** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the curve adjustment. See *Section 1, Standard Curve Adjustment* for more information. If you are using a reagent blank correction, the blank correction should be entered before the Standard Adjust value is entered.

## Method Performance

### Precision

In a single laboratory using standard solutions of 25.0 mg/L nitrate nitrogen ( $\text{NO}_3^-$ -N) and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of  $\pm 0.3$  mg/L nitrate nitrogen for program #50 and  $\pm 1.7$  mg/L nitrate nitrogen for program # 51.

## NITRATE, High Range, continued

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### Estimated Detection Limit

The estimated detection limit for program 50 is 0.5 mg/L  $\text{NO}_3^-$ -N and 0.8 mg/L  $\text{NO}_3^-$ -N for program 51. For more information on the estimated detection limit, see *Section 1*.

### Interferences

Interfering Substance	Interference Levels and Treatments
Chloride	Chloride concentrations above 100 mg/L will cause low results. The test may be used at high chloride concentrations (seawater) but a calibration must be done using standards spiked to the same chloride concentration.
Ferric iron	All levels
Nitrite	All levels Compensate for nitrite interference as follows: Add 30-g/L Bromine Water dropwise to the sample in Step 3 until a yellow color remains. Add one drop of 30-g/L Phenol Solution to destroy the color. Proceed with Step 4. Report the results as total nitrate and nitrite.
pH	Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.
Strong oxidizing and reducing substances	Interfere at all levels.

### Summary Of Method

Cadmium metal reduces nitrates present in the sample to nitrite. The nitrite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt which couples to gentisic acid to form an amber-colored product.

### Pollution Prevention and Waste Management

NitraVer 5 contains cadmium metal. Both samples and reagent blanks will contain cadmium (D006) at a concentration regulated as hazardous wastes by the Federal RCRA. Do not pour these solutions down the drain. See *Section 3* for more information on proper disposal of these materials.

## NITRATE, High Range, continued

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### REQUIRED REAGENTS & APPARATUS (Using Powder Pillows)

Description	Quantity Required		Unit	Cat. No.
	Per Test			
NitraVer 5 Nitrate Reagent Powder Pillows.....	1 pillow	.....	100/pkg	.....21061-69
Sample Cell, 10-20-25 mL, w/cap .....	2	.....	6/pkg	.....24019-06

### REQUIRED REAGENTS (Using AccuVac Ampuls)

NitraVer 5 Nitrate Reagent AccuVac Ampul .....	1 ampul	.....	25/pkg	.....25110-25
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### REQUIRED APPARATUS (Using AccuVac Ampuls)

Beaker, 50 mL .....	1	.....	each	.....500-41H
Stopper .....	1	.....	6/pkg	.....1731-06

### OPTIONAL REAGENTS

Bromine Water 30 g/L .....	29 mL *	.....	2211-20
Nitrate Nitrogen Standard Solution, 10.0 mg/L as (NO <sub>3</sub> <sup>-</sup> -N) .....	500 mL	.....	307-49
Nitrate Nitrogen Standard Solution, 1000 mg/L as (NO <sub>3</sub> <sup>-</sup> -N) .....	500 mL	.....	12792-49
Nitrate Nitrogen Standard Solution, PourRite ampule, 500 mg/L as NO <sub>3</sub> <sup>-</sup> -N, 2 mL .....	20/pkg	.....	14260-20
Phenol Solution .....	29 mL	.....	2112-20
Sodium Hydroxide Standard Solution, 5.0 N.....	50 mL*	.....	2450-26
Sulfuric Acid, ACS .....	500 mL*	.....	979-49
Water, deionized .....	4 L	.....	272-56

### OPTIONAL APPARATUS

AccuVac Snapper Kit .....	each	.....	24052-00
Cylinder, graduated, mixing, 25 mL .....	each	.....	1896-40
Dropper, for 29-mL bottle .....	each	.....	2258-00
pH Indicator Paper, 1 to 11 pH.....	5 rolls/pkg	.....	391-33
pH Meter, <i>sensio</i> <sup>™</sup> <b>1</b> , portable, with electrode.....	each	.....	51700-10
Pipet Filler, safety bulb .....	each	.....	14651-00
Pipet, serological, 2 mL.....	each	.....	532-36
Pipet, TenSette, 0.1 to 1.0 mL .....	each	.....	19700-01
Pipet Tips, for 19700-01 TenSette Pipet .....	50/pkg	.....	21856-96
Pipet Tips, for 19700-01 TenSette Pipet .....	1000/pkg	.....	21856-28
PourRite Ampule Breaker .....	each	.....	24846-00
Thermometer, -20 to 110 °C, non-mercury .....	each	.....	26357-02

### *For Technical Assistance, Price and Ordering*

In the U.S.A. call 800-227-4224

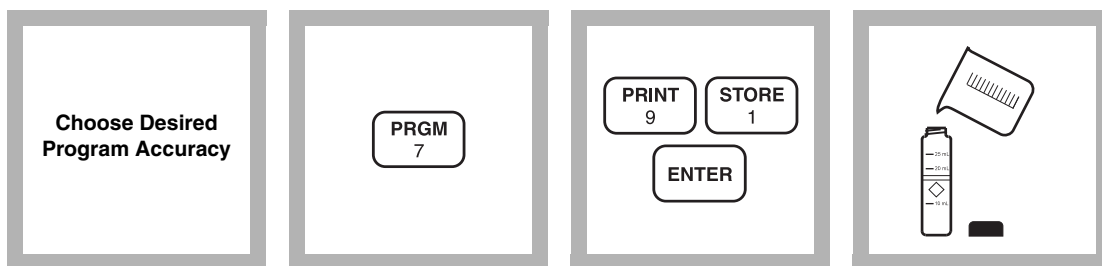
Outside the U.S.A.—Contact the Hach office or distributor serving you.

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\* Contact Hach for larger sizes.

**SULFATE (0 to 70 mg/L)****For water, wastewater, and seawater**

**SulfaVer 4 Method<sup>\*</sup> (Powder Pillows or AccuVac Ampuls); USEPA accepted for reporting wastewater analysis<sup>\*\*</sup>**

**Using Powder Pillows**

**1.** A User-Entered Calibration is necessary to obtain the most accurate results. See the *User Calibration* section at the back of this procedure. Program 91 can be used for process control or applications where a high degree of accuracy is not needed.

***Note:** The nature of turbidimetric tests and reagent lot variation requires user calibration for best results.*

**2.** Enter the stored program number for sulfate ( $\text{SO}_4^-$ ).  
Press: **PRGM**  
The display will show:  
**PRGM ?**

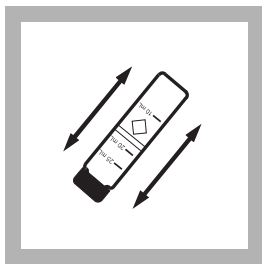
**3.** Press: **91 ENTER** or the program number selected for a user-entered calibration.  
The display will show **mg/L, SO4** and the **ZERO** icon.

**4.** Fill a clean sample cell with 10 mL of sample.

***Note:** Filter highly turbid or colored samples. Use filtered sample in this step and as the blank.*

<sup>\*</sup> Adapted from *Standard Methods for the Examination of Water and Wastewater*.

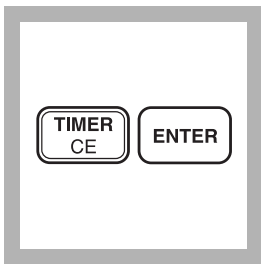
<sup>\*\*</sup> Procedure is equivalent to USEPA method 375.4 for wastewater.



**5.** Add the contents of one SulfaVer 4 Sulfate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and invert several times to mix.

*Note:* A white turbidity will develop if sulfate is present in the sample.

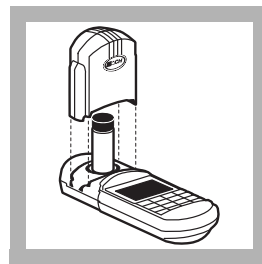
*Note:* Accuracy is not affected by undissolved powder.



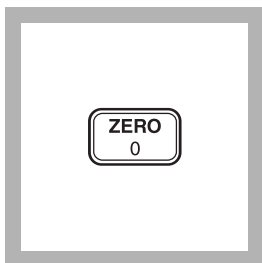
**6. Press:**  
**TIMER ENTER**  
A 5-minute reaction period will begin.  
Allow the cell to stand undisturbed.



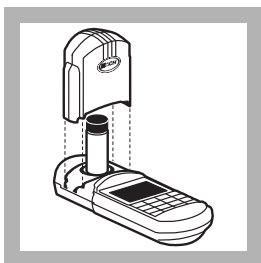
**7.** After the timer beeps, fill a second sample cell with 10 mL of sample (the blank).



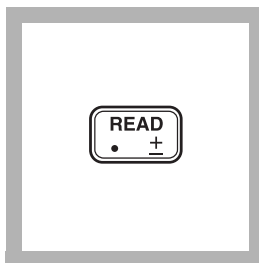
**8.** Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



**9. Press: ZERO**  
The cursor will move to the right, then the display will show:  
**0 mg/L SO<sub>4</sub>**



**10.** Within five minutes after the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



**11. Press: READ**  
The cursor will move to the right, then the result in mg/L sulfate will be displayed.

*Note:* If Program 91 is used, use of the Standard Adjust is highly recommended. See Accuracy Check.

*Note:* Clean the sample cells with soap and a brush.

## Using AccuVac Ampuls

**Choose Desired  
Program Accuracy**

**1.** A User-Entered Calibration is necessary to obtain the most accurate results. See User Calibration Section at the back of this procedure. Program 92 can be used for process control or applications where a high degree of accuracy is not needed.

**PRGM  
7**

**2.** Enter the stored program number for sulfate ( $\text{SO}_4^-$ )-AccuVac Ampuls.

Press: **PRGM**

The display will show:  
**PRGM ?**

**PRINT  
9**      **RECALL  
2**

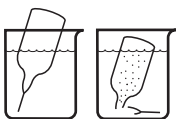
**ENTER**

**3.** Press: **92 ENTER**  
The display will show **mg/L, SO4** and the **ZERO** icon.



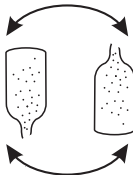
**4.** Fill a sample cell with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50-mL beaker.

***Note:** Filter highly turbid or colored samples. Use filtered sample in this step and as the blank.*



**5.** Fill a SulfaVer 4 Sulfate AccuVac Ampul with sample.

***Note:** Keep tip immersed until the ampul fills completely.*



**6.** Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

***Note:** A white turbidity will develop if sulfate is present.*

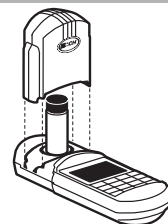
***Note:** Accuracy is not affected by undissolved powder.*

**TIMER  
CE**      **ENTER**

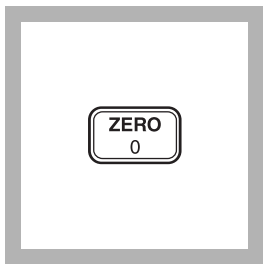
**7.** Press:  
**TIMER ENTER**

A 5-minute reaction period will begin.

***Note:** Allow the ampul to stand undisturbed.*



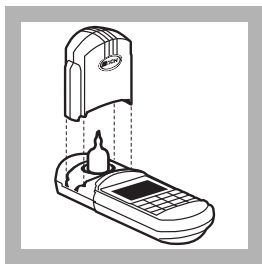
**8.** After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



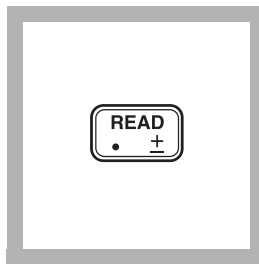
**9. Press: ZERO**

The cursor will move to the right, then the display will show:

**0 mg/L SO<sub>4</sub>**



**10.** Within five minutes after the timer beeps, place the AccuVac ampul into the cell holder. Tightly cover the sample cell with the instrument cap.



**11. Press: READ**

The cursor will move to the right, then the result in mg/L sulfate will be displayed.

*Note: If Program 92 is used, use of the Standard Adjust is highly recommended. See Accuracy Check.*

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## User- Entered Calibration

There are various programs to determine sulfate, each with a different level of accuracy. Best results are obtained by performing a user-entered calibration with each new lot of reagent. Programs 91 and 92 can be run when a high degree of accuracy is not needed. Use of the Standard Adjust feature will improve performance when using programs 91 and 92. It should NOT be used with a user calibration, as it will hinder performance.

Using Class A glassware, prepare standards of 10, 20, 30, 40, 50, 60, and 70 mg/L sulfate by pipetting 1, 2, 3, 4, 5, 6, and 7 mL of a 1000-mg/L sulfate standard into 100-mL volumetric flasks. Dilute to the mark with deionized water and mix well.

Zero the instrument with water. The user-entered settings for sulfate are:

Program number: #101 to 105  
Wavelength: 520 nm  
Resolution: 0 mg/L

See *Creating User-Entered Program* in the instrument manual for specific instructions on entering a user-entered program.

### Sampling and Storage

Collect samples in clean plastic or glass bottles. Samples may be stored up to 28 days by cooling to 4 °C (39 °F) or lower. Warm to room temperature before analysis.

### Accuracy Check

#### Standard Additions Method- Powder Pillows

- a) Snap the neck off a Sulfate Standard PourRite Ampule, 1000 mg/L  $\text{SO}_4^{2-}$ .
- b) Use a TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard to the three 10-mL samples. Mix thoroughly.
- c) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.
- d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

#### Standard Additions Method- AccuVac Ampuls

- a) Snap the neck off a Sulfate Standard PourRite Ampule, 2500 mg/L  $\text{SO}_4^{2-}$ .
- b) Fill three 25- mL graduated cylinders with 25 mL of sample. Use a TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard to the three cylinders. Mix thoroughly. For AccuVac Ampuls, transfer to a 50-mL beaker.
- c) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.
- d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

#### Standard Solution Method

Check the accuracy of the test by using the Sulfate Standard Solution,

50 mg/L, listed under Optional Reagents. Or, prepare this solution by pipetting 1.0 mL of a PourRite Ampule Standard for Sulfate (2500 mg/L) into a 50-mL volumetric flask. Dilute to volume with deionized water. The final concentration is 50 mg/L sulfate. Substitute this standard for the sample and proceed with the test as described in the procedure.



### Standard Adjust

Standard adjust is recommended when using stored programs 91 or 92. It **should not** be used with a user-entered calibration.

To adjust the calibration curve using the reading obtained with the

50-mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **50** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the adjustment. See *Section 1, Standard Curve Adjustment* for more information.

## Method Performance

### Precision

In a single laboratory, using a standard solution of 50 mg/L sulfate and two representative lots of powder pillows with the instrument, a single operator obtained a standard deviation of  $\pm 0.5$  mg/L sulfate.

In a single laboratory, using a standard solution of 50 mg/L sulfate and two representative lots of AccuVac Ampuls with the instrument, a single operator obtained a standard deviation of  $\pm 3$  mg/L sulfate.

### Estimated Detection Limit (EDL)

The EDL for program 91 is 4.9 mg/L  $\text{SO}_4$  and the EDL for program 92 is 3 mg/L  $\text{SO}_4$ . For more information on derivation and use of Hach's estimated detection limit, see *Section 1*.

## Interferences

The following interfere at levels above those concentrations listed:

Calcium: 20,000 mg/L as $\text{CaCO}_3$	Magnesium: 10,000 mg/L as $\text{CaCO}_3$
Chloride: 40,000 mg/L as $\text{Cl}^-$	Silica: 500 mg/L as $\text{CaCO}_3$

## Summary of Method

Sulfate ions in the sample react with barium in the SulfaVer 4 Sulfate Reagent to form insoluble barium sulfate. The amount of turbidity formed is proportional to the sulfate concentration. The SulfaVer 4 also contains a stabilizing agent to hold the precipitate in suspension.

## SULFATE, continued

### REQUIRED REAGENTS AND APPARATUS (Using Powder Pillows)

Description	Quantity Required		Units	Cat. No.
	Per Test			
SulfaVer 4 Sulfate Reagent Powder Pillows .....	1 pillow.....	100/pkg .....	21067-69	
Sample Cell, 10-20-25 mL, w/ cap .....	2 .....	6/pkg .....	24019-06	

### REQUIRED REAGENTS AND APPARATUS (Using AccuVac Ampuls)

SulfaVer 4 Sulfate AccuVac Ampuls .....	1 ampul.....	25/pkg .....	25090-25
Beaker, 50-mL.....	1 .....	each .....	500-41H

### OPTIONAL REAGENTS

Standard, Drinking Water Inorganics, F <sup>-</sup> , NO <sub>3</sub> <sup>-N</sup> , PO <sub>4</sub> <sup>-3</sup> , SO <sub>4</sub> <sup>-2</sup> .....	500 mL .....	28330-49
Standard, Wastewater Effluent Inorganics, NH <sub>3</sub> <sup>-N</sup> , NO <sub>3</sub> <sup>-N</sup> , PO <sub>4</sub> <sup>-3</sup> , COD, SO <sub>4</sub> <sup>-2</sup> , TOC.....	500 mL .....	28332-49
Sulfate Standard Solution, 50 mg/L .....	500 mL .....	2578-49
Sulfate Standard Solution, 1000 mg/L .....	500 mL .....	21757-49
Sulfate Standard Solution, PourRite Ampule, 2500 mg/L, 10 mL .....	16/pkg .....	14252-10
Sulfate Standard Solution, PourRite Ampule, 1000 mg/L, 2 mL .....	20/pkg .....	21757-20
Water, deionized .....	4 L .....	272-56

### OPTIONAL APPARATUS

AccuVac Snapper Kit .....	each .....	24052-00
Cylinder, graduated mixing, 25 mL .....	each .....	20886-40
Filter Paper, folded, 12.5 cm .....	100/pkg .....	1894-57
Flask, volumetric, 50 mL, Class A.....	each .....	14574-41
Funnel, poly, 65 mm.....	each .....	1083-67
Pipet, TenSette, 0.1 to 1.0 mL .....	each .....	19700-01
Pipet Tips, for 19700-01 Pipet .....	50/pkg .....	21856-96
Pipet, volumetric, 1.00 mL, Class A .....	each .....	14515-35
Pipet, volumetric, 2.00 mL, Class A .....	each .....	14515-36
Pipet, volumetric, 3.00 mL, Class A .....	each .....	14515-03
Pipet, volumetric, 4.00 mL, Class A .....	each .....	14515-04
Pipet, volumetric, 5.00 mL, Class A .....	each .....	14515-37
Pipet, volumetric, 6.00 mL, Class A .....	each .....	14515-06
Pipet, volumetric, 7.00 mL, Class A .....	each .....	14515-07
Pipet Filler, safety bulb .....	each .....	14651-00
PourRite Ampule Breaker .....	each .....	24846-00

### *For Technical Assistance, Price and Ordering*

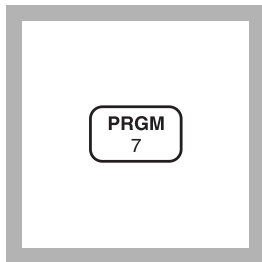
In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.

**PHOSPHORUS, REACTIVE (0 to 2.50 mg/L PO<sub>4</sub><sup>3-</sup>)** For water, wastewater, seawater**(Also called Orthophosphate) PhosVer 3 (Ascorbic Acid) Method\***

(Powder Pillows or AccuVac Ampuls)

USEPA Accepted for wastewater analysis reporting\*\*

**Using Powder Pillows**

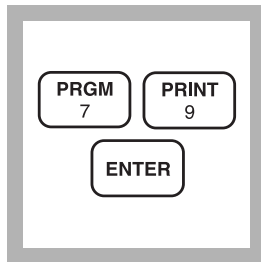
**1.** Enter the stored program number for reactive phosphorus, ascorbic acid method.

Press: **PRGM**

The display will show:

**PRGM ?**

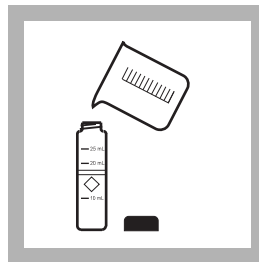
***Note:** For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



**2.** Press: **79 ENTER**

The display will show **mg/L, PO<sub>4</sub>** and the **ZERO** icon.

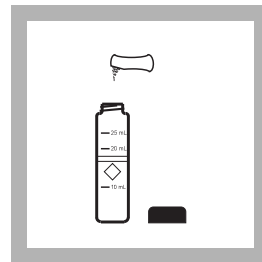
***Note:** For alternate forms (P, P<sub>2</sub>O<sub>5</sub>), press the **CONC** key.*



**3.** Fill a sample cell with 10 mL of sample.

***Note:** For samples with extreme pH, see Interferences following these steps.*

***Note:** Clean glassware with 1:1 HCl. Rinse again with deionized water. Do not use detergents containing phosphates to clean glassware.*

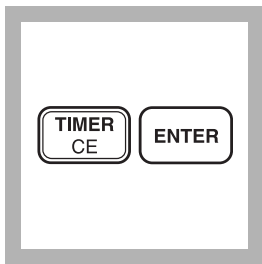


**4.** Add the contents of one PhosVer 3 Phosphate Powder Pillow for 10-mL sample to the cell (the prepared sample). Shake for 15 seconds.

***Note:** A blue color will form if phosphate is present.*

\* Adapted from *Standard Methods for the Examination of Water and Wastewater*.

\*\* Procedure is equivalent to USEPA method 365.2 and Standard Method 4500-PE for wastewater.

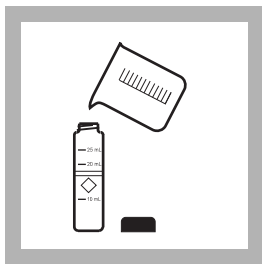


5. Press:

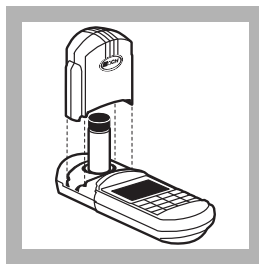
## TIMER ENTER

A two-minute reaction period will begin. Perform Steps 6-8 during this period.

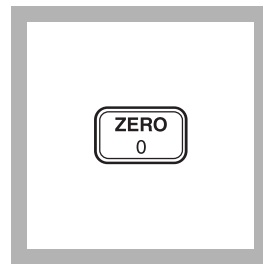
*Note: If the acid-persulfate digestion was used, an 8-10 minute reaction period is required.*



6. Fill another sample cell with 10 mL of sample (the blank).



7. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

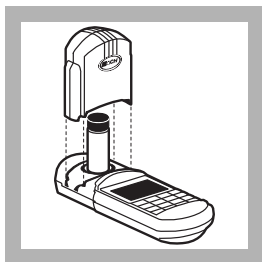


8. Press: **ZERO**

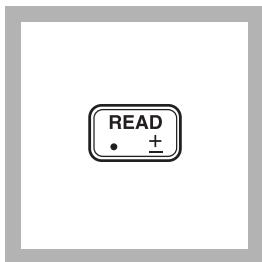
The cursor will move to the right, then the display will show:

**0.00 mg/L PO<sub>4</sub>**

*Note: If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



9. After the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

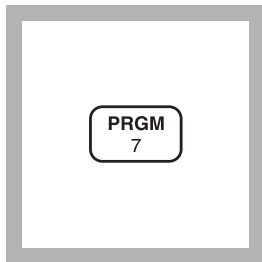


10. Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate ( $\text{PO}_4^{3-}$ ) will be displayed.

*Note: Standard Adjust may be performed using a 2.0-mg/L  $\text{PO}_4^{3-}$  standard; see Section 1.*

## Using AccuVac Ampuls



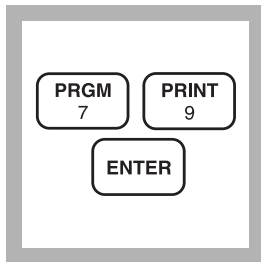
1. Enter the stored program number for reactive phosphorus-ascorbic acid method.

Press: **PRGM**

The display will show:

**PRGM ?**

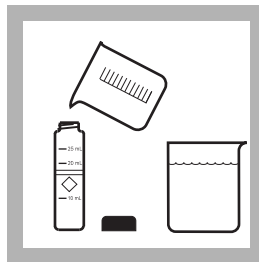
*Note: For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



2. Press: **79 ENTER**

The display will show **mg/L, PO<sub>4</sub>** and the **ZERO** icon.

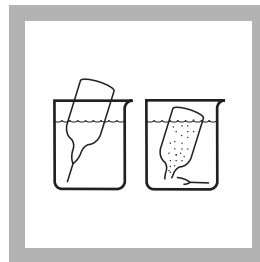
*Note: For alternate forms (P, P<sub>2</sub>O<sub>5</sub>), press the **CONC** key.*



3. Fill a sample cell (the blank) with at least 10 mL of sample. Collect at least 40 mL of sample in a 50-mL beaker.

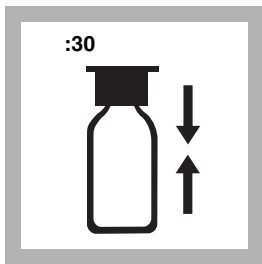
*Note: For samples with extreme pH, see Interferences.*

*Note: Clean glassware with 1:1 HCl. Rinse again with deionized water. Do not use detergent containing phosphates to clean glassware.*



4. Fill a PhosVer 3 Phosphate AccuVac Ampul with sample.

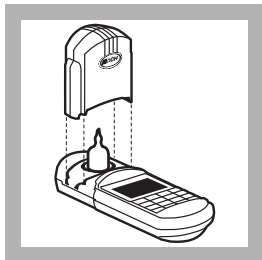
*Note: Keep the tip immersed while the ampul fills completely.*



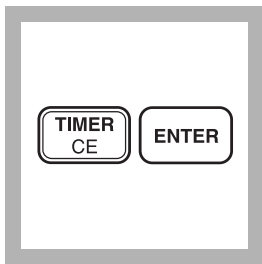
**5.** Place an ampul cap securely over the tip of the ampul. Shake the ampul for about 30 seconds. Wipe off any liquid or fingerprints.

*Note:* A blue color will form if phosphate is present.

*Note:* Accuracy is not affected by undissolved powder.



**9.** After the timer beeps, place the AccuVac ampul into the cell holder. Tightly cover the ampul with the instrument cap.

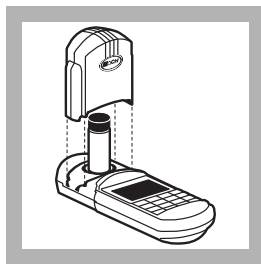


**6.** Press:

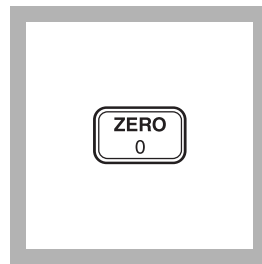
**TIMER ENTER**

A two-minute reaction period will begin. Perform Steps 7-8 during this period.

*Note:* Use an 8-10 minute reaction period if determining total phosphorus following the acid-persulfate digestion.



**7.** Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

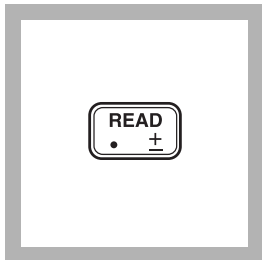


**8.** Press: **ZERO**

The cursor will move to the right, then the display will show:

**0.00 mg/L PO<sub>4</sub>**

*Note:* If Reagent Blank Correction is on, the display may flash "limit". See Section 1.



**10.** Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (PO<sub>4</sub><sup>3-</sup>) will be displayed.

*Note:* Standard Adjust may be performed using a 2.0-mg/L PO<sub>4</sub><sup>3-</sup> standard; see Section 1.

### Sampling and Storage

Collect sample in plastic or glass bottles that have been cleaned with 1:1 Hydrochloric Acid Solution and rinsed with deionized water. Do not use commercial detergents containing phosphate for cleaning glassware used in this test.

Analyze samples immediately after collection for best results. If prompt analysis is impossible, preserve samples for up to 48 hours by filtering immediately and storing samples at 4 °C. Warm to room temperature before testing.

### Accuracy Check

#### Standard Additions Method

- a) Fill three 25-mL graduated mixing cylinders with 25 mL of sample.
- b) Snap the neck off a Phosphate PourRite Ampule Standard Solution, 50 mg/L as  $\text{PO}_4^{3-}$ .
- c) Use the TenSette Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to the three mixing cylinders. Stopper each and mix thoroughly.
- d) For analysis with AccuVacs, transfer solutions to dry, clean 50 mL beakers to fill the AccuVac ampules. For analysis with powder pillows, transfer only 10 mL of solution to the sample cells.
- e) Analyze each standard addition sample as described in the procedure. The phosphate concentration should increase 0.2 mg/L  $\text{PO}_4^{3-}$  for each 0.1 mL of standard added.
- f) If these increases do not occur, see *Standard Additions* in *Section 1*.

#### Standard Solution Method

Prepare a 2.0 mg/L  $\text{PO}_4^{3-}$  standard solution by pipetting 4.0 mL of Phosphate Standard Solution, 50 mg/L as  $\text{PO}_4^{3-}$ , into an acid-washed Class A 100-mL volumetric flask. Dilute to volume with deionized water. Stopper and invert to mix. Use this solution in place of the sample in the procedure to insure the accuracy of the test. The mg/L  $\text{PO}_4^{3-}$  reading should be 2.00 mg/L.

# PHOSPHORUS, REACTIVE, continued

## Method Performance

### Precision

In a single laboratory using a standard solution of 1.00 mg/L  $\text{PO}_4^{3-}$  and two lots of reagents with the instrument, a single operator obtained a standard deviation of  $\pm 0.05$  mg/L  $\text{PO}_4^{3-}$ .

In a single laboratory using a standard solution of 1.00 mg/L  $\text{PO}_4^{3-}$  and two representative lots of AccuVac ampuls with the instrument, a single operator obtained a standard deviation of  $\pm 0.03$  mg/L  $\text{PO}_4^{3-}$ .

### Estimated Detection Limit (EDL)

The EDL for program 79 is 0.05 mg/L  $\text{PO}_4$ . For more information on the estimated detection limit, see *Section 1*.

### Interference

Interfering Substance	Interference Levels and Treatments
Aluminum	Greater than 200 mg/L
Arsenate	All levels
Chromium	Greater than 100 mg/L
Copper	Greater than 10 mg/L
Hydrogen sulfide	All levels
Iron	Greater than 100 mg/L
Nickel	Greater than 300 mg/L
Silica	Greater than 50 mg/L
Silicate	Greater than 10 mg/L
Turbidity or color	Large amounts may cause inconsistent results in the test because the acid present in the powder pillows may dissolve some of the suspended particles and because of variable desorption of orthophosphate from the particles. For highly turbid or colored samples, add the contents of one Phosphate Pretreatment Pillow to 25 mL of sample. Mix well. Use this solution to zero the instrument.
Zinc	Greater than 80 mg/L
Highly buffered samples or extreme sample pH	May exceed the buffering capacity of the reagents and require sample pretreatment. pH 2 to 10 is recommended.

### Summary of Method

Orthophosphate reacts with molybdate in an acid medium to produce a Phosphomolybdate complex. Ascorbic acid then reduces the complex, giving an intense molybdenum blue color.



# PHOSPHORUS, REACTIVE, continued

## REQUIRED REAGENTS & APPARATUS (Using Powder Pillows)

Description	Quantity Required		Unit	Cat. No.
	Per Test			
PhosVer 3 Phosphate Reagent Powder Pillows				
10 mL sample size .....	1 Pillow .....	100/pkg.....	21060-69	
Sample Cell, 10-20-25 mL, w/cap .....	2.....	6/pkg.....	24019-06	

## REQUIRED REAGENTS & APPARATUS (Using AccuVac Ampuls)

PhosVer 3 Phosphate Reagent AccuVac Ampuls....	1 ampul .....	25/pkg.....	25080-25
Beaker, 50 mL .....	1 .....	each.....	500-41
Cap, ampul, blue .....	1 .....	25/pkg.....	1731-25
Sample Cell, 10-20-25 mL, w/cap .....	1 .....	6/pkg.....	24019-06

## OPTIONAL REAGENTS

Drinking Water Standard, Inorganic, F <sup>-</sup> , NO <sub>3</sub> <sup>-N</sup> , PO <sub>4</sub> <sup>3-</sup> , SO <sub>4</sub> <sup>2-</sup> .....	500mL .....	28330-49
Hydrochloric Acid Standard Solution, 6.0 N (1:1) .....	500 mL.....	884-49
Phosphate Standard Solution, 1mg/L .....	500mL.....	2569-49
Phosphate Standard Solution, PourRite ampule,		
50 mg/L as PO <sub>4</sub> <sup>3-</sup> , 2 mL .....	20/pkg.....	171-20
Phosphate Standard Solution, Voluette Ampul, 50 mg/L, 10 mL .....	16/pkg.....	171-10
Sodium Hydroxide Standard Solution, 5.0 N .....	100 mL* MDB.....	2450-32
Wastewater Effluent Standard, Inorganic		
(NH <sub>3</sub> -N, NO <sub>3</sub> -N, PO <sub>4</sub> , COD, SO <sub>4</sub> , TOC) .....	500 mL .....	28332-49
Water, deionized .....	4 L.....	272-56

## OPTIONAL APPARATUS

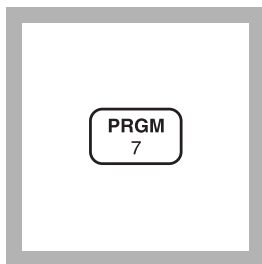
AccuVac Snapper Kit .....	each.....	24052-00
Ampule Breaker Kit for 10-ml ampules.....	each.....	21968-00
Aspirator, vacuum .....	each.....	2131-00
Cylinder, graduated, mixing, 25 mL, tall (3 required) .....	each.....	20886-40
Filter Holder, 47 mm, 300 mL, graduated.....	each.....	13529-00
Filter, membrane, 47 mm, 0.45 microns .....	100/pkg.....	13530-00
Flask, filtering, 500 mL.....	each.....	546-49
Flask, volumetric, Class A, 100 mL.....	each.....	14574-42
pH Indicator Paper, 1 to 11 pH .....	5 rolls/pkg .....	391-33
pH Meter, <i>Sension</i> <sup>TM</sup> 1, portable with electrode .....	each.....	51700-10
Pipet, 2 mL serological .....	each.....	532-36
Pipet, TenSette, 0.1 to 1.0 mL TenSette Pipet.....	each.....	19700-01
Pipet Tips, for 19700-01 .....	50/pkg.....	21856-96
Pipet Tips, for 19700-01 .....	1000/pkg.....	21856-28
Pipet Filler, safety bulb .....	each.....	14651-00
Pipet, volumetric, Class A, 4.00 mL .....	each.....	14515-04
PourRite Ampule Breaker Kit .....	each.....	24846-00

Outside the U.S.A.—Contact the Hach office or distributor serving you.

\* Larger sizes available.

**PHOSPHORUS, REACTIVE (0 to 45.0 mg/L PO<sub>4</sub><sup>3-</sup>) For water and wastewater**

**(Also called Orthophosphate) Molybdovanadate Method\***  
**(Reagent Solution or AccuVac Ampuls)**

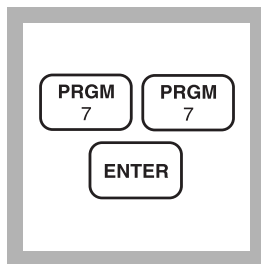
**Using Reagent Solution**

**1.** Enter the stored program number for high range phosphate (PO<sub>4</sub><sup>3-</sup>) reagent solution.

Press: **PRGM**

The display will show:

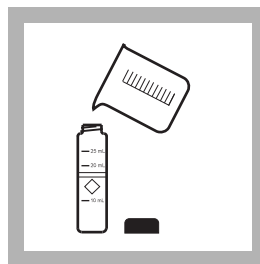
**PRGM ?**



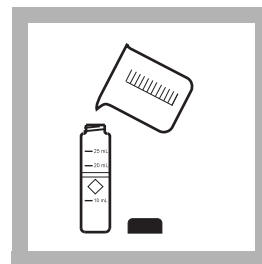
**2.** Press: **77 ENTER**

The display will show **mg/L, PO4** and the **ZERO** icon.

*Note:* For alternate forms (P, P<sub>2</sub>O<sub>5</sub>), press the **CONC** key.

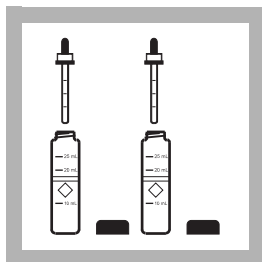


**3.** Fill a sample cell with 25 mL of deionized water (the blank).



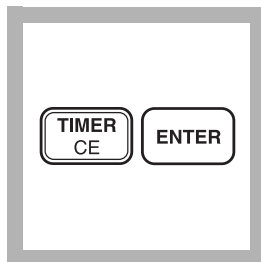
**4.** Fill another sample cell with 25 mL of sample (the prepared sample).

*Note:* For best results, the sample temperature should be 20-25 °C.



**5.** Add 1.0 mL of Molybdovanadate Reagent to each sample cell. Cap the cells and invert to mix.

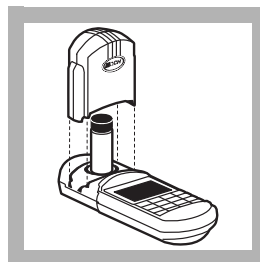
*Note:* A yellow color will form if phosphate is present. A small amount of yellow will be present in the blank, because of the reagent.



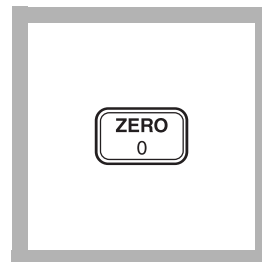
**6.** Press:

**TIMER ENTER**

A five-minute reaction period will begin.



**7.** After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

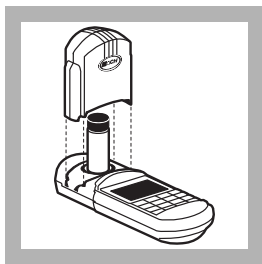


**8.** Press: **ZERO**

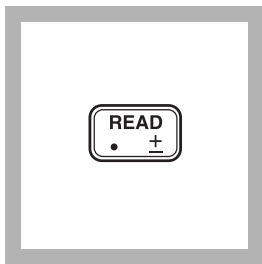
The cursor will move to the right, then the display will show:

**0.0 mg/L PO4**

\* Adapted from *Standard Methods for the Examination of Water and Wastewater*.



**9.** Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

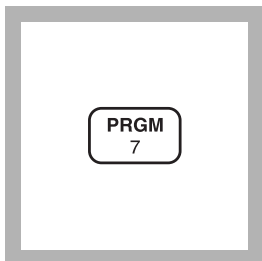


**10.** Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (or alternate form) will be displayed.

*Note: Use of the Standard Adjust feature with each new lot of reagent is highly recommended. See Accuracy Check.*

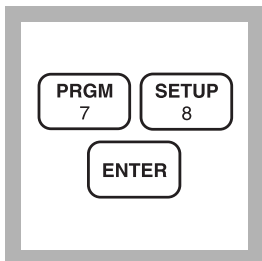
## Using AccuVac Ampuls



**1.** Enter the stored program number for high range phosphate ( $\text{PO}_4^{3-}$ )-AccuVac Ampuls.

Press: **PRGM**

The display will show:  
**PRGM ?**



**2.** Press: **78 ENTER**

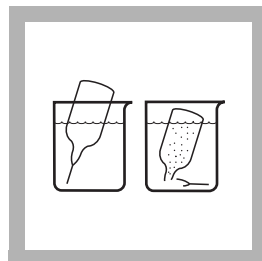
The display will show **mg/L, PO<sub>4</sub>** and the **ZERO** icon.

*Note: For alternate forms (P,  $\text{P}_2\text{O}_5$ ), press the **CONC** key.*



**3.** Collect at least 40 mL of sample in a 50-mL beaker. Pour at least 40 mL of deionized water into a second beaker.

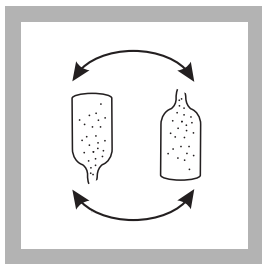
*Note: For best results, sample temperature should be 20-25 °C.*



**4.** Fill a Molybdo-vanadate Reagent AccuVac Ampul with sample. Fill a second AccuVac Ampul with deionized water (the blank).

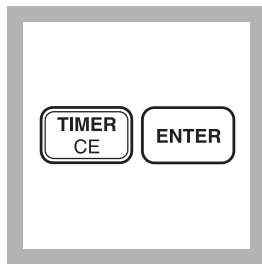
*Note: Keep the tip immersed while the ampul fills completely.*

## PHOSPHORUS, REACTIVE, continued

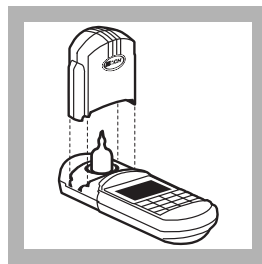


5. Invert the ampul several times to mix, then wipe off any liquid or fingerprints.

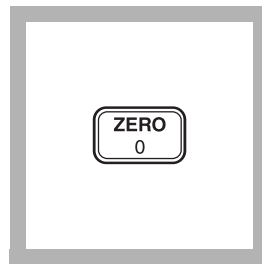
*Note: A yellow color will form if phosphate is present. A small amount of yellow will be present in the blank because of the reagent.*



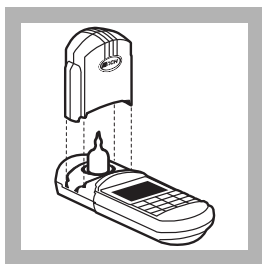
6. Press: **TIMER ENTER**  
A five-minute reaction period will begin.



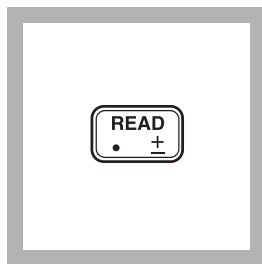
7. After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



8. Press: **ZERO**  
The cursor will move to the right, then the display will show:  
**0.0 mg/L PO<sub>4</sub>**



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: **READ**  
The cursor will move to the right, then the result in mg/L phosphate (or alternate form) will be displayed.  
*Note: Use of the Standard Adjust feature with each new lot of reagent is highly recommended. See Accuracy Check.*

### Sampling and Storage

Collect samples in clean plastic or glass bottles that have been cleaned with 1:1 Hydrochloric Acid Solution and rinsed with deionized water.

Do not use a commercial detergent containing phosphate for cleaning glassware used in this test.

## PHOSPHORUS, REACTIVE, continued

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Analyze samples immediately for best results. If prompt analysis is impossible, preserve samples by filtering immediately and storing at 4 °C for up to 48 hours.

### Accuracy Check

#### Standard Additions Method

- a) Fill three 25-mL graduated mixing cylinders with 25 mL of sample.
- b) Snap the neck off a Phosphate Voluette Ampule Standard Solution, 500 mg/L as  $\text{PO}_4^{3-}$ .
- c) Use the TenSette Pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard, respectively, to the three mixing cylinders. Stopper and invert to mix well.
- d) For analysis with AccuVac Ampuls, transfer the spiked samples to clean, dry 50-mL beakers to facilitate filling of the ampuls. For analysis with reagent solution, transfer the spiked samples to 25-mL sample cells.
- e) Analyze each sample as described in the procedure. Each 0.1-mL addition of standard should cause an increase of 2.0 mg/L  $\text{PO}_4^{3-}$ .
- f) If these increases do not occur, see *Standard Additions* (Section 1) for more information.

#### Standard Solution Method

Obtain a Hach Phosphate Standard Solution, 10.0 mg/L as phosphate. Using this solution as the sample, perform the phosphate procedure as described above.

#### Standard Adjust

To adjust the calibration curve using the reading obtained with the

10.0 mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **10.0** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the adjustment. See *Standard Curve Adjustment, Section 1* for more information.

# PHOSPHORUS, REACTIVE, continued

## Method Performance

### Precision

In a single laboratory using a standard solution of 30.0 mg/L  $\text{PO}_4^{3-}$ , two lots of reagent, and the instrument, a single operator obtained a standard deviation of  $\pm 0.1$  mg/L  $\text{PO}_4^{3-}$  for the reagent solution method and a standard deviation of  $\pm 0.2$  for the AccuVac Ampul method.

### Estimated Detection Limit

The estimated detection limit for program 77 is 0.3 mg/L  $\text{PO}_4^{3-}$  and 0.4 mg/L  $\text{PO}_4^{3-}$  for program 78. For more information on the estimated detection limit, see *Section 1*.

## Interferences

### Interfering Substances and Suggested Treatment

Interfering Substance	Interference Level and Treatment
Arsenate	Only interferes if sample is heated.
Iron, ferrous	Blue color caused by ferrous iron does not interfere if iron concentration is less than 100 mg/L.
Molybdate	Causes negative interference above 1000 mg/L.
Silica	Only interferes if sample is heated.
Sulfide	Causes a negative interference. Remove interference as follows: <b>1.</b> Measure 50 mL of sample into an erlenmeyer flask. <b>2.</b> Add Bromine Water drop-wise with constant swirling until a permanent yellow color develops. <b>3.</b> Add Phenol Solution drop-wise until the yellow color just disappears. Proceed with step 4 of the procedure (step 3 if using the AccuVac procedure).
Extreme pH or highly buffered samples	May exceed buffering capacity of reagents. See Section 1, <i>pH Interferences</i> . Samples may require pretreatment. Sample pH should be about 7.
Fluoride, thorium, bismuth, thiosulfate or thiocyanate	Cause negative interference
The following do not interfere in concentrations up to 1000 mg/L: Pyrophosphate, tetraborate, selenate benzoate, citrate, oxalate, lactate, tartrate, formate, salicylate, $\text{Al}^{3+}$ , $\text{Fe}^{3+}$ , $\text{Mg}^{2+}$ , $\text{Ca}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , $\text{NH}_4^+$ , $\text{Cd}^{2+}$ , $\text{Mn}^{2+}$ , $\text{NO}_3^-$ , $\text{NO}_2^-$ , $\text{SO}_4^{2-}$ , $\text{SO}_3^{2-}$ , $\text{Pb}^{2+}$ , $\text{Hg}^+$ , $\text{Hg}^{2+}$ , $\text{Sn}^{2+}$ , $\text{Cu}^{2+}$ , $\text{Ni}^{2+}$ , $\text{Ag}^+$ , $\text{U}^{4+}$ , $\text{Zr}^{4+}$ , $\text{AsO}_3^-$ , $\text{Br}^-$ , $\text{CO}_3^{2-}$ , $\text{ClO}_4^-$ , $\text{CN}^-$ , $\text{IO}_3^-$ , $\text{SiO}_4^{4-}$ .	

# PHOSPHORUS, REACTIVE, continued

## Summary of Method

In the molybdovanadate method, orthophosphate reacts with molybdate in an acid medium to produce a phosphomolybdate complex. In the presence of vanadium, yellow vanadomolybdophosphoric acid is formed. The intensity of the yellow color is proportional to the phosphate concentration.

## REQUIRED REAGENTS AND APPARATUS (using Reagent Solution)

Description	Quantity Required		Cat. No.
	Per Test	Units	
Molybdovanadate Reagent .....	2.0 mL ..... 100 mL*	MDB.....	20760-32
Sample Cell, 10-20-25 mL, w/ cap .....	2 .....	6/pkg.....	24019-06
Water, deionized.....	25 mL .....	4 L .....	272-56

## REQUIRED REAGENTS AND APPARATUS (using AccuVac Ampuls)

Molybdovanadate Reagent AccuVac Ampuls .....	2 .....	25/pkg.....	25250-25
Beaker, 50 mL.....	2 .....	each.....	500-41H
Water, deionized.....	25 mL .....	4 L .....	272-56

## OPTIONAL REAGENTS

Description	Units	Cat. No.
Bromine Water, 30 g/L.....	29 mL *	2211-20
Hydrochloric Acid Solution, 1:1 (6.0 N).....	500 mL.....	884-49
Phenol Solution, 30 g/L .....	29 mL.....	2112-20
Phosphate Standard Solution, 10.0 mg/L as $\text{PO}_4^{3-}$ .....	946 mL.....	14204-16
Phosphate Standard Solution, Voluette Ampule, 500 mg/L as $\text{PO}_4^{3-}$ , 10 mL .....	16/pkg.....	14242-10
Sodium Hydroxide Standard Solution, 5.0 N .....	100 mL * MDB.....	2450-32
Sulfuric Acid, ACS .....	500 mL *	979-49
Wastewater Influent Standard, Inorganic ( $\text{NH}_3\text{-N}$ , $\text{NO}_3\text{-N}$ , $\text{PO}_4$ , COD, $\text{SO}_4$ , TOC).....	500 mL.....	28331-49

## OPTIONAL APPARATUS

AccuVac Snapper Kit.....	each.....	24052-00
Ampule Breaker Kit.....	each.....	21968-00
Cylinder, graduated, 25 mL .....	each.....	508-40
Cylinder, graduated, mixing, 25-mL.....	each.....	20886-40
Dispenser, fixed volume, 1.0 mL Repipet Jr.....	each.....	21113-02
Flask, erlenmeyer, 50 mL .....	each.....	505-41
Flask, volumetric, Class A, 50 mL .....	each.....	14574-41
pH Paper, 1 to 11 pH units.....	5 rolls/pkg .....	391-33
pH Meter, <i>Sension</i> <sup>TM</sup> 1, portable with electrode .....	each.....	51700-10

\* Contact Hach for larger sizes.

PHOSPHORUS, REACTIVE, continued

OPTIONAL APPARATUS (continued)

Description	Units	Cat. No.
Pipet, serological, 2.0 mL.....	each .....	532-36
Pipet, TenSette, 0.1 to 1.0 mL .....	each .....	19700-01
Pipet Tips, for 19700-01 TenSette Pipet .....	50/pkg .....	21856-96
Pipet Tips, for 19700-01 TenSette Pipet .....	1000/pkg .....	21856-28
Thermometer, -20 to 110 °C.....	each .....	26357-02

*For Technical Assistance, Price and Ordering*

In the U.S.A.—Call 800-227-4224  
Outside the U.S.A.—Contact the Hach office or distributor serving you.



The following list contains the Material Safety Data Sheets you requested. Please scroll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2511025	N/A	Hach Company	OSHA	English	1
2509025	N/A	Hach Company	OSHA	English	1
2508025	N/A	Hach Company	OSHA	English	1
2525025	N/A	Hach Company	OSHA	English	1

---

Total Enclosures: 4

World Headquarters  
Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

MSDS No: M00164

# MATERIAL SAFETY DATA SHEET

---

## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

**Product Name:** NitraVer® 5 Nitrate Reagent

**Catalog Number:** 2511025

Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

Emergency Telephone Numbers:  
(Medical and Transportation)  
(303) 623-5716 24 Hour Service  
(515)232-2533 8am - 4pm CST

**MSDS Number:** M00164

**Chemical Name:** Not applicable

**CAS No.:** Not applicable

**Chemical Formula:** Not applicable

**Chemical Family:** Not applicable

**Hazard:** Toxic. Recognized carcinogen. Cumulative poison. Experimental teratogen. May cause irritation.

**Date of MSDS Preparation:**

**Day:** 05

**Month:** October

**Year:** 2007

---

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

### Potassium Phosphate

**CAS No.:** 7778-77-0

**TSCA CAS Number:** 7778-77-0

**Percent Range:** 30.0 - 40.0

**Percent Range Units:** weight / weight

**LD50:** Oral rat LD50 = 7100 mg/kg

**LC50:** None reported

**TLV:** Not established

**PEL:** Not established

**Hazard:** May cause irritation.

### Other components, each

**CAS No.:** Not applicable

**TSCA CAS Number:** Not applicable

**Percent Range:** < 1.0

**Percent Range Units:** weight / weight

**LD50:** Not applicable

**LC50:** Not applicable

**TLV:** Not established

**PEL:** Not established

**Hazard:** Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

### Cadmium

**CAS No.:** 7440-43-9

**TSCA CAS Number:** 7440-43-9

**Percent Range:** 5.0 - 10.0

**Percent Range Units:** weight / weight

**LD50:** Oral rat LD50 = 225 mg/kg

**LC50:** Inhalation rat LC50 = 25 mg/m<sup>3</sup>/30min

**TLV:** 0.01 mg/m<sup>3</sup>

**PEL:** 0.005 mg/m<sup>3</sup>

**Hazard:** Toxic. Recognized carcinogen. Cumulative poison. May cause irritation. Experimental teratogen.

#### **Gentisic Acid**

**CAS No.:** 490-79-9

**TSCA CAS Number:** 490-79-9

**Percent Range:** 5.0 - 15.0

**Percent Range Units:** weight / weight

**LD50:** Oral rat LD50 = 800 mg/kg, Oral mouse LD50 = 4500 mg/kg

**LC50:** None reported

**TLV:** Not established

**PEL:** Not established

**Hazard:** May cause irritation.

#### **Magnesium Sulfate**

**CAS No.:** 10034-99-8

**TSCA CAS Number:** 7487-88-9

**Percent Range:** 5.0 - 15.0

**Percent Range Units:** weight / weight

**LD50:** Oral mouse LDLo = 5000 mg/kg

**LC50:** None reported

**TLV:** Not established

**PEL:** Not established

**Hazard:** May cause irritation.

#### **Sulfanilic Acid**

**CAS No.:** 121-57-3

**TSCA CAS Number:** 121-57-3

**Percent Range:** 30.0 - 40.0

**Percent Range Units:** weight / weight

**LD50:** Oral rat LD50 = 12300 mg/kg

**LC50:** None reported

**TLV:** Not established

**PEL:** Not established

**Hazard:** May cause irritation.

---

### **3. HAZARDS IDENTIFICATION**

#### ***Emergency Overview:***

**Appearance:** Gray powder

**Odor:** None

HARMFUL IF SWALLOWED OR INHALED MAY CAUSE EYE, SKIN AND RESPIRATORY TRACT IRRITATION

CONTAINS CADMIUM: CANCER HAZARD CAN CAUSE LUNG AND KIDNEY DISEASE

#### ***HMIS:***

**Health:** 4

**Flammability:** 1

**Reactivity:** 0

**Protective Equipment:** X - See protective equipment, Section 8.

**NFPA:**

**Health:** 3

**Flammability:** 1

**Reactivity:** 0

**Symbol:** Not applicable

**Potential Health Effects:**

**Eye Contact:** May cause irritation

**Skin Contact:** May cause irritation

**Skin Absorption:** None reported

**Target Organs:** None reported

**Ingestion:** May cause: salivation vomiting abdominal pain anemia diarrhea kidney failure central nervous system effects

**Target Organs:** Kidneys Reproductive system Central nervous system

**Inhalation:** May cause: coughing headache nausea, vomiting chest pain pneumonitis respiratory tract irritation lung damage kidney damage

**Target Organs:** Kidneys Reproductive system Lungs

**Medical Conditions Aggravated:** Pre-existing: Respiratory conditions Kidney conditions

**Chronic Effects:** Chronic overexposure may cause cancer kidney damage liver damage bone damage (osteosclerosis)

**Cancer / Reproductive Toxicity Information:**

An ingredient of this product is an OSHA listed carcinogen.

Cadmium

An ingredient of this mixture is: IARC Group 2A: Suspected Carcinogen

Cadmium

An ingredient of this mixture is: NTP Listed Group 2A: Suspected Carcinogen

Cadmium

**Additional Cancer / Reproductive Toxicity Information:** Contains: an experimental teratogen. In laboratory tests, when magnesium sulfate was given to pregnant rats, a sharp reduction of both the number and the weight of the offspring was observed.

**Toxicologically Synergistic Products:** None reported

---

## 4. FIRST AID

**Eye Contact:** Immediately flush eyes with water for 15 minutes. Call physician.

**Skin Contact (First Aid):** Wash skin with soap and plenty of water. Call physician if irritation develops.

**Ingestion (First Aid):** Administer milk or beaten egg whites at frequent intervals. Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.

**Inhalation:** Remove to fresh air. Give artificial respiration if necessary. Call physician.

---

## 5. FIRE FIGHTING MEASURES

**Flammable Properties:** Can burn in fire, releasing toxic vapors.

**Flash Point:** Not applicable

**Method:** Not applicable

**Flammability Limits:**

**Lower Explosion Limits:** Not applicable

**Upper Explosion Limits:** Not applicable

**Autoignition Temperature:** Not available

**Hazardous Combustion Products:** Toxic fumes of: cadmium oxide sulfur oxides. phosphorus oxides carbon monoxide, carbon dioxide.

**Fire / Explosion Hazards:** None reported

**Static Discharge:** None reported.

**Mechanical Impact:** None reported

**Extinguishing Media:** Use media appropriate to surrounding fire conditions

**Fire Fighting Instruction:** As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

---

## 6. ACCIDENTAL RELEASE MEASURES

**Spill Response Notice:**

Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.

**Containment Technique:** Stop spilled material from being released to the environment. Releases of this material may contaminate the environment.

**Clean-up Technique:** Avoid breathing spilled material. Sweep up material. Incinerate material at an E.P.A. approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.

**Evacuation Procedure:** Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.

**Special Instructions (for accidental release):** Product is regulated as RCRA hazardous waste.

**304 EHS RQ (40 CFR 355):** Not applicable

**D.O.T. Emergency Response Guide Number:** None

---

## 7. HANDLING / STORAGE

**Handling:** Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product. Use with adequate ventilation.

**Storage:** Protect from: moisture Keep away from: oxidizers powdered metals hydrazoic acid

**Flammability Class:** Not applicable

---

## 8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

**Engineering Controls:** Use a fume hood to avoid exposure to dust, mist or vapor. Have an eyewash station nearby.

**Personal Protective Equipment:**

**Eye Protection:** safety glasses with top and side shields

**Skin Protection:** disposable latex gloves lab coat

**Inhalation Protection:** laboratory fume hood

**Precautionary Measures:** Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Protect from: moisture Keep away from: oxidizers powdered metals

**TLV:** Not established

**PEL:** Not established

---

## 9. PHYSICAL / CHEMICAL PROPERTIES

**Appearance:** Gray powder

**Physical State:** Solid

**Molecular Weight:** Not applicable

**Odor:** None

**pH:** 5% solution = 2.7

**Vapor Pressure:** Not applicable

**Vapor Density (air = 1):** Not applicable

**Boiling Point:** Not applicable

**Melting Point:** 175°C; 347°F

**Specific Gravity (water = 1):** 2.13

**Evaporation Rate (water = 1):** Not applicable  
**Volatile Organic Compounds Content:** Not applicable  
**Partition Coefficient (n-octanol / water):** Not applicable  
**Solubility:**

**Water:** Slightly soluble

**Acid:** Slightly soluble

**Other:** Not determined

**Metal Corrosivity:**

**Steel:** 0.105 in/yr

**Aluminum:** 0.028 in/yr

---

## 10. STABILITY / REACTIVITY

**Chemical Stability:** Stable when stored under proper conditions.

**Conditions to Avoid:** Excess moisture

**Reactivity / Incompatibility:** Incompatible with: oxidizers powdered metals hydrazoic acid

**Hazardous Decomposition:** Heating to decomposition releases toxic and/or corrosive fumes of: sulfur oxides phosphorus oxides cadmium oxide carbon dioxide carbon monoxide

**Hazardous Polymerization:** Will not occur.

---

## 11. TOXICOLOGICAL INFORMATION

**Product Toxicological Data:**

**LD50:** None reported

**LC50:** None reported

**Dermal Toxicity Data:** None reported

**Skin and Eye Irritation Data:** Sulfanilic acid: Skin rabbit - 500 mg/24H Standard Draize - MILD, Eye rabbit - 100 mg/24H Standard Draize - MODERATE

**Mutation Data:** Cadmium - Cytogenetic analysis - hamster ovary 1 µmol/l; Gentisic acid - DNA Inhibition - Human Lymphocytes 1 mmol/l

**Reproductive Effects Data:** Cadmium: Oral male rat TDLo = 155 mg/kg - 13 weeks pre-mating - effects on newborn growth and behavior; Oral female rat TDLo = 23 mg/kg - 1-22 days after conception - blood and lymphatic system abnormalities

**Ingredient Toxicological Data:** Cadmium: Oral rat LD50 = 225 mg/kg, Inhalation rat LC50 = 25 mg/m<sup>3</sup>/30 min; Sulfanilic acid Oral rat LD50 = 12300 mg/kg; Gentisic acid Oral rat LD50 = 800 mg/kg; Potassium Phosphate Monobasic Oral rat LD50 = 7100 mg/kg

---

## 12. ECOLOGICAL INFORMATION

**Product Ecological Information:** --

No ecological data available for this product.

**Ingredient Ecological Information:** --

No ecological data available for the ingredients of this product.

---

## 13. DISPOSAL CONSIDERATIONS

**EPA Waste ID Number:** D006

**Special Instructions (Disposal):** Incinerate material at an E.P.A. approved hazardous waste facility.

**Empty Containers:** Rinse three times with an appropriate solvent. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste. Dispose of empty container as normal trash.

**NOTICE (Disposal):** These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

---

## 14. TRANSPORT INFORMATION

### **D.O.T.:**

**D.O.T. Proper Shipping Name:** Not Currently Regulated

--

**DOT Hazard Class:** NA

**DOT Subsidiary Risk:** NA

**DOT ID Number:** NA

**DOT Packing Group:** NA

### **I.C.A.O.:**

**I.C.A.O. Proper Shipping Name:** Not Currently Regulated

--

**ICAO Hazard Class:** NA

**ICAO Subsidiary Risk:** NA

**ICAO ID Number:** NA

**ICAO Packing Group:** NA

### **I.M.O.:**

**I.M.O. Proper Shipping Name:** Not Currently Regulated

--

**I.M.O. Hazard Class:** NA

**I.M.O. Subsidiary Risk:** NA

**I.M.O. ID Number:** NA

**I.M.O. Packing Group:** NA

**Additional Information:** There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply. ALSO NOTE: If the National Competent Authority declares this product an environmental hazard by Special Provision 909 (IMDG) and Special Provision A97 (IATA) the classification may be UN3077 or UN3082.

---

## 15. REGULATORY INFORMATION

### **U.S. Federal Regulations:**

**O.S.H.A.:** This product contains Cadmium and is regulated under 29CFR Subpart Z 1910.1027. This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

### **E.P.A.:**

**S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370):** Immediate (Acute) Health Hazard  
Delayed (Chronic) Health Hazard

**S.A.R.A. Title III Section 313 (40 CFR 372):** This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.

Cadmium

**302 (EHS) TPQ (40 CFR 355):** Not applicable

**304 CERCLA RQ (40 CFR 302.4):** Cadmium 10 lbs.

**304 EHS RQ (40 CFR 355):** Not applicable

**Clean Water Act (40 CFR 116.4):** Not applicable

**RCRA:** Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.

**C.P.S.C.:** Not applicable

### **State Regulations:**

**California Prop. 65:** WARNING - This product contains a chemical known to the State of California to cause cancer.

**Identification of Prop. 65 Ingredient(s):** Cadmium

**California Perchlorate Rule CCR Title 22 Chap 33:**

**Trade Secret Registry:** Not applicable

**National Inventories:**

**U.S. Inventory Status:** All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

**TSCA CAS Number:** Not applicable

---

## 16. OTHER INFORMATION

**Intended Use:** Determination of nitrate

**References:** 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992.

NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. Cincinnati: Department of Health and Human Services, 1981. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. In-house information. Technical Judgment.

**Revision Summary:** Updates in Section(s) 14,

---

### Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

**USER RESPONSIBILITY:** Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

**THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.**

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*World Headquarters  
Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050*

*MSDS No: M00046*

## MATERIAL SAFETY DATA SHEET

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### 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

*Product Name:* SulfaVer ® 4 Sulfate Reagent  
*Catalog Number:* 2509025

Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

Emergency Telephone Numbers:  
(Medical and Transportation)  
(303) 623-5716 24 Hour Service  
(515)232-2533 8am - 4pm CST

*MSDS Number:* M00046  
*Chemical Name:* Not applicable  
*CAS No.:* Not applicable  
*Chemical Formula:* Not applicable  
*Chemical Family:* Not applicable  
*Hazard:* Causes severe eye irritation.  
*Date of MSDS Preparation:*  
*Day:* 26  
*Month:* August  
*Year:* 2011

---

### 2. COMPOSITION / INFORMATION ON INGREDIENTS

#### Barium Chloride

*CAS No.:* 10361-37-2  
*TSCA CAS Number:* 10361-37-2  
*Percent Range:* 40.0 - 50.0  
*Percent Range Units:* weight / weight  
*LD50:* Oral rat LD50 = 118 mg/kg Oral Human LDLo = 11400 µg/kg  
*LC50:* None reported  
*TLV:* 0.5 mg/m<sup>3</sup> as Ba  
*PEL:* 0.5 mg/m<sup>3</sup> as Ba  
*Hazard:* May cause irritation. Toxic.

#### Citric Acid

*CAS No.:* 77-92-9  
*TSCA CAS Number:* 77-92-9  
*Percent Range:* 55.0 - 65.0  
*Percent Range Units:* weight / weight  
*LD50:* Oral rat LD50 = 6730 mg/Kg  
*LC50:* None reported  
*TLV:* Not established  
*PEL:* Not established  
*Hazard:* Causes irritation.

---

### 3. HAZARDS IDENTIFICATION

*Emergency Overview:*  
*Appearance:* White powder  
*Odor:* None

CAUSES EYE IRRITATION MAY CAUSE SKIN AND RESPIRATORY TRACT IRRITATION

**HMS:**

**Health:** 2

**Flammability:** 0

**Reactivity:** 0

**Protective Equipment:** X - See protective equipment, Section 8.

**NFPA:**

**Health:** 2

**Flammability:** 1

**Reactivity:** 0

**Symbol:** Not applicable

**Potential Health Effects:**

**Eye Contact:** Causes severe irritation

**Skin Contact:** Causes moderate irritation

**Skin Absorption:** None reported

**Target Organs:** None reported

**Ingestion:** Barium compounds cause central nervous system stimulation followed by central nervous system depression. Barium compounds cause stimulation of the muscles which may result in muscle twitching, cramps and weakness; blood pressure effects; disturbance of the heart's action and respiratory paralysis. Causes: abdominal pain dizziness Can cause: paralysis of tongue limb immobility death kidney damage

**Target Organs:** Cardiovascular system Central nervous system Muscles Kidneys

**Inhalation:** Barium compounds cause central nervous system stimulation followed by central nervous system depression. Barium compounds cause stimulation of the muscles which may result in muscle twitching, cramps and weakness; blood pressure effects; disturbance in the heart's action and respiratory paralysis. Causes: abdominal pain dizziness Can cause: paralysis of tongue limb immobility death kidney damage

**Target Organs:** Cardiovascular system Central nervous system Muscles Kidneys

**Medical Conditions Aggravated:** None reported

**Chronic Effects:** Citric acid chronic overexposure may cause effects due to the ability of citric acid to chelate metals, which could impair the body's ability to absorb calcium and iron. Chronic overexposure may cause kidney damage

**Cancer / Reproductive Toxicity Information:**

This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

**Additional Cancer / Reproductive Toxicity Information:** None reported

**Toxicologically Synergistic Products:** None reported

---

## 4. FIRST AID

**Eye Contact:** Immediately flush eyes with water for 15 minutes. Call physician.

**Skin Contact (First Aid):** Wash skin with plenty of water. Call physician if irritation develops.

**Ingestion (First Aid):** Induce vomiting using syrup of ipecac or by sticking finger down throat. Give 1 tablespoon of epsom salt in a glass of water. Call physician immediately. Never give anything by mouth to an unconscious person.

**Inhalation:** Remove to fresh air. Give artificial respiration if necessary. Call physician.

---

## 5. FIRE FIGHTING MEASURES

**Flammable Properties:** Can burn in fire, releasing toxic vapors. During a fire, irritating and highly toxic gases may be generated by thermal decomposition.

**Flash Point:** Not applicable

**Method:** Not applicable

**Flammability Limits:**

**Lower Explosion Limits:** Not applicable

**Upper Explosion Limits:** Not applicable

**Autoignition Temperature:** Not determined

**Hazardous Combustion Products:** Toxic fumes of: carbon monoxide, carbon dioxide. chlorides

**Fire / Explosion Hazards:** May react violently with: strong oxidizers

**Static Discharge:** None reported.

**Mechanical Impact:** None reported

**Extinguishing Media:** Use media appropriate to surrounding fire conditions

**Fire Fighting Instruction:** As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

---

## 6. ACCIDENTAL RELEASE MEASURES

### ***Spill Response Notice:***

Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance. Outside of the US, only persons properly qualified according to state or local regulations should respond to a spill involving chemicals.

***Containment Technique:*** Releases of this material may contaminate the environment. Stop spilled material from being released to the environment.

***Clean-up Technique:*** Avoid contact with spilled material. Sweep up material. Dispose of material in government approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.

***Evacuation Procedure:*** Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.

***Special Instructions (for accidental release):*** Mixture contains a component which is regulated as hazardous waste in the U. S. .

***304 EHS RQ (40 CFR 355):*** Not applicable

***D.O.T. Emergency Response Guide Number:*** None

---

## 7. HANDLING / STORAGE

***Handling:*** Avoid contact with: eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.

***Storage:*** Store away from: oxidizers Protect from: moisture

***Flammability Class:*** Not applicable

---

## 8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

***Engineering Controls:*** Use a fume hood to avoid exposure to dust, mist or vapor. Maintain general industrial hygiene practices when using this product.

### ***Personal Protective Equipment:***

***Eye Protection:*** safety glasses with top and side shields

***Skin Protection:*** disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it. lab coat

***Inhalation Protection:*** adequate ventilation

***Precautionary Measures:*** Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Protect from: moisture Keep away from: oxidizers

***TLV:*** Not established

***PEL:*** Not established

---

## 9. PHYSICAL / CHEMICAL PROPERTIES

***Appearance:*** White powder

***Physical State:*** Solid

***Molecular Weight:*** Not applicable

***Odor:*** None

***pH:*** of a 5% solution ~ 2.0

***Vapor Pressure:*** Not applicable

***Vapor Density (air = 1):*** Not applicable

***Boiling Point:*** Not applicable

***Melting Point:*** ~ 124 °C (255 °F)

***Specific Gravity/ Relative Density (water = 1; air =1):*** ~2

***Evaporation Rate (water = 1):*** Not applicable

***Volatile Organic Compounds Content:*** Not applicable

***Partition Coefficient (n-octanol / water):*** Not applicable

### ***Solubility:***

***Water:*** Soluble

***Acid:*** Not determined

***Other:*** Not determined

***Metal Corrosivity:***

*Steel:* Not applicable  
*Aluminum:* Not applicable

---

## 10. STABILITY / REACTIVITY

**Chemical Stability:** Stable when stored under proper conditions.

**Conditions to Avoid:** Excess moisture Extreme temperatures

**Reactivity / Incompatibility:** Incompatible with: oxidizers bromine trifluoride 2-furan percarboxylic acid metal nitrates metal nitrites

**Hazardous Decomposition:** Heating to decomposition releases toxic and/or corrosive fumes of: carbon dioxide carbon monoxide chlorides

**Hazardous Polymerization:** Will not occur.

---

## 11. TOXICOLOGICAL INFORMATION

**Product Toxicological Data:**

**LD50:** Oral rat LD50 = 680 mg/kg

**LC50:** None reported

**Dermal Toxicity Data:** None reported

**Skin and Eye Irritation Data:** Citric Acid: Standard Draize Test Skin rabbit 500 mg/24 hour = MODERATE. Citric Acid: Standard Draize Test Eye rabbit 750 µg/24 hour = SEVERE.

**Mutation Data:** None reported

**Reproductive Effects Data:** None reported

**Ingredient Toxicological Data:** Barium Chloride Oral rat LD50 = 118 mg/kg; Citric Acid Oral rat LD50 = 6730 mg/kg

---

## 12. ECOLOGICAL INFORMATION

**Product Ecological Information:** --

No ecological data available for this product. Mobility in soil: No data available

**Ingredient Ecological Information:** --

No ecological data available for the ingredients of this product.

---

## 13. DISPOSAL CONSIDERATIONS

**EPA Waste ID Number:** D005

**Special Instructions (Disposal):** Dispose of material in an E.P.A. approved hazardous waste facility.

**Empty Containers:** Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.

**NOTICE (Disposal):** These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

---

## 14. TRANSPORT INFORMATION

**D.O.T.:**

**D.O.T. Proper Shipping Name:** Not Currently Regulated

--

**DOT Hazard Class:** NA

**DOT Subsidiary Risk:** NA

**DOT ID Number:** NA

**DOT Packing Group:** NA

**I.C.A.O.:**

**I.C.A.O. Proper Shipping Name:** Not Currently Regulated

--

**ICAO Hazard Class:** NA

**ICAO Subsidiary Risk:** NA

**ICAO ID Number:** NA

**ICAO Packing Group:** NA

**I.M.O.:**

**I.M.O. Proper Shipping Name:** Not Currently Regulated

--

**I.M.O. Hazard Class:** NA

**I.M.O. Subsidiary Risk:** NA

**I.M.O. ID Number:** NA

**I.M.O. Packing Group:** NA

**Additional Information:** There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

---

## 15. REGULATORY INFORMATION

### **U.S. Federal Regulations:**

**O.S.H.A.:** This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

### **E.P.A.:**

**S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370):** Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

**S.A.R.A. Title III Section 313 (40 CFR 372):** This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.

Barium Chloride

**302 (EHS) TPQ (40 CFR 355):** Not applicable

**304 CERCLA RQ (40 CFR 302.4):** Not applicable

**304 EHS RQ (40 CFR 355):** Not applicable

**Clean Water Act (40 CFR 116.4):** Not applicable

**RCRA:** Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.

**C.P.S.C.:** Not applicable

### **State Regulations:**

**California Prop. 65:** No Prop. 65 listed chemicals are present in this product.

**Identification of Prop. 65 Ingredient(s):** Not applicable

**California Perchlorate Rule CCR Title 22 Chap 33:** Not applicable

**Trade Secret Registry:** Not applicable

### **National Inventories:**

**U.S. Inventory Status:** All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

**TSCA CAS Number:** Not applicable

---

## 16. OTHER INFORMATION

**Intended Use:** Laboratory Reagent Sulfate determination

**References:** TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. In-house information. Technical Judgment. Outside Testing. Vendor Information. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Edition. Volume 2. New York: A Wiley-Interscience Publication, 1981. NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U.S. Department of Health and Human Services, April, 1987.

**Revision Summary:** Substantial revision to comply with EU Reg 1272/2008, Reg 1907/2006 and UN GHS (ST/SG/AC.10/36/Add.3).

---

### **Legend:**

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

**USER RESPONSIBILITY:** Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

**THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.**



World Headquarters  
Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

MSDS No: M00035

# MATERIAL SAFETY DATA SHEET

---

## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

**Product Name:** PhosVer ® 3 Phosphate Reagent  
**Catalog Number:** 2508025

Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

Emergency Telephone Numbers:  
(Medical and Transportation)  
(303) 623-5716 24 Hour Service  
(515)232-2533 8am - 4pm CST

**MSDS Number:** M00035  
**Chemical Name:** Not applicable  
**CAS No.:** Not applicable  
**Chemical Formula:** Not applicable  
**Chemical Family:** Not applicable  
**Hazard:** Causes eye burns.  
**Date of MSDS Preparation:**  
**Day:** 15  
**Month:** October  
**Year:** 2009

---

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

### Potassium Pyrosulfate

**CAS No.:** 7790-62-7  
**TSCA CAS Number:** 7790-62-7  
**Percent Range:** 75.0 - 85.0  
**Percent Range Units:** weight / weight  
**LD50:** Oral rat LD50 = 2340 mg/kg  
**LC50:** None reported  
**TLV:** Not established  
**PEL:** Not established  
**Hazard:** Causes eye burns.

### Ascorbic Acid

**CAS No.:** 50-81-7  
**TSCA CAS Number:** 50-81-7  
**Percent Range:** 15.0 - 25.0  
**Percent Range Units:** weight / weight  
**LD50:** Oral rat LD50 = 11900 mg/kg  
**LC50:** None reported  
**TLV:** Not established  
**PEL:** Not established  
**Hazard:** Practically non-toxic.

### Sodium Molybdate

**CAS No.:** 10102-40-6  
**TSCA CAS Number:** 7631-95-0  
**Percent Range:** 1.0 - 10.0  
**Percent Range Units:** weight / weight  
**LD50:** Oral rat LD<sub>50</sub> = 4000 mg/kg.  
**LC50:** Inhalation rat LC50 = > 2080 mg/m<sup>3</sup>/4 hrs  
**TLV:** 5 mg/m<sup>3</sup> (as Mo)

**PEL:** 5 mg/m<sup>3</sup> (as Mo)

**Hazard:** May cause irritation.

**Other components, each**

**CAS No.:** Not applicable

**TSCA CAS Number:** Not applicable

**Percent Range:** 0.1 - 1.0

**Percent Range Units:** weight / weight

**LD50:** Not applicable

**LC50:** Not applicable

**TLV:** Not established

**PEL:** Not established

**Hazard:** Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

---

### 3. HAZARDS IDENTIFICATION

***Emergency Overview:***

**Appearance:** White to off-white powder

**Odor:** None

CAUSES EYE BURNS MAY CAUSE RESPIRATORY TRACT IRRITATION

***HMIS:***

**Health:** 3

**Flammability:** 1

**Reactivity:** 0

**Protective Equipment:** X - See protective equipment, Section 8.

***NFPA:***

**Health:** 3

**Flammability:** 1

**Reactivity:** 0

**Symbol:** Not applicable

***Potential Health Effects:***

**Eye Contact:** Causes eye burns.

**Skin Contact:** No effects are anticipated

**Skin Absorption:** None reported

**Target Organs:** None reported

**Ingestion:** May cause: copper deficiency anemia gout loss of appetite loss of coordination listlessness diarrhea liver damage May effect enzyme activity.

**Target Organs:** Blood Liver

**Inhalation:** May cause: respiratory tract irritation Effects similar to those of ingestion.

**Target Organs:** Blood Liver

**Medical Conditions Aggravated:** Pre-existing: Eye conditions Respiratory conditions Gout

**Chronic Effects:** Chronic overexposure may cause copper deficiency enzyme activity effects liver damage Molybdenum poisoning signs include loss of appetite, listlessness and reduced growth rate. Excessive exposure to molybdenum compounds may cause gout and anemia.

***Cancer / Reproductive Toxicity Information:***

This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

**Additional Cancer / Reproductive Toxicity Information:** Contains: an experimental mutagen.

**Toxicologically Synergistic Products:** None reported

---

### 4. FIRST AID



**Eye Contact:** Immediately flush eyes with water for 15 minutes. Call physician.

**Skin Contact (First Aid):** Wash skin with plenty of water.

**Ingestion (First Aid):** Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.

**Inhalation:** Remove to fresh air. Give artificial respiration if necessary. Call physician.

---

## 5. FIRE FIGHTING MEASURES

**Flammable Properties:** Can burn in fire, releasing toxic vapors.

**Flash Point:** Not applicable

**Method:** Not applicable

**Flammability Limits:**

**Lower Explosion Limits:** Not applicable

**Upper Explosion Limits:** Not applicable

**Autoignition Temperature:** Not determined

**Hazardous Combustion Products:** Toxic fumes of: sulfur oxides. carbon monoxide, carbon dioxide. sodium monoxide

**Fire / Explosion Hazards:** None reported

**Static Discharge:** None reported.

**Mechanical Impact:** None reported

**Extinguishing Media:** Use media appropriate to surrounding fire conditions

**Fire Fighting Instruction:** As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

---

## 6. ACCIDENTAL RELEASE MEASURES

**Spill Response Notice:**

Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.

**Containment Technique:** Stop spilled material from being released to the environment.

**Clean-up Technique:** Scoop up spilled material into a large beaker and dissolve with water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.

**Evacuation Procedure:** Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled.

**Special Instructions (for accidental release):** Not applicable

**304 EHS RQ (40 CFR 355):** Not applicable

**D.O.T. Emergency Response Guide Number:** None

---

## 7. HANDLING / STORAGE

**Handling:** Avoid contact with eyes Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.

**Storage:** Store between 10° and 25°C.

**Flammability Class:** Not applicable

---

## 8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

**Engineering Controls:** Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.

**Personal Protective Equipment:**

**Eye Protection:** safety glasses with top and side shields

**Skin Protection:** disposable latex gloves lab coat

**Inhalation Protection:** adequate ventilation

**Precautionary Measures:** Avoid contact with: eyes Do not breathe: dust Wash thoroughly after handling.

**TLV:** Not established

**PEL:** Not established

---

## 9. PHYSICAL / CHEMICAL PROPERTIES

**Appearance:** White to off-white powder  
**Physical State:** Solid  
**Molecular Weight:** Not applicable  
**Odor:** None  
**pH:** of a 5% solution = 1.5  
**Vapor Pressure:** Not applicable  
**Vapor Density (air = 1):** Not applicable  
**Boiling Point:** Not applicable  
**Melting Point:** 105 °C (221 °F)  
**Specific Gravity (water = 1):** 2.22  
**Evaporation Rate (water = 1):** Not applicable  
**Volatile Organic Compounds Content:** Not applicable  
**Partition Coefficient (n-octanol / water):** Not applicable  
**Solubility:**  
    **Water:** Soluble  
    **Acid:** Soluble  
    **Other:** Not determined  
**Metal Corrosivity:**  
    **Steel:** Not applicable  
    **Aluminum:** Not applicable

---

## 10. STABILITY / REACTIVITY

**Chemical Stability:** Stable when stored under proper conditions.  
**Conditions to Avoid:** Extreme temperatures  
**Reactivity / Incompatibility:** Incompatible with: oxidizers dyes alkalies iron copper  
**Hazardous Decomposition:** Heating to decomposition releases: carbon dioxide carbon monoxide sulfur oxides  
**Hazardous Polymerization:** Will not occur.

---

## 11. TOXICOLOGICAL INFORMATION

**Product Toxicological Data:**  
    **LD50:** None reported  
    **LC50:** None reported  
    **Dermal Toxicity Data:** None reported  
    **Skin and Eye Irritation Data:** Not corrosive to skin, no erythema  
    **Mutation Data:** None reported  
    **Reproductive Effects Data:** None reported  
**Ingredient Toxicological Data:** Potassium Pyrosulfate Oral rat LD50 = 2340 mg/kg; Sodium Molybdate Oral rat LD50 = 4000 mg/kg, Inhalation rat LC50 > 2080mg/m<sup>3</sup>/4 hr; Ascorbic Acid Oral rat LD50 = 11.9 g/kg

---

## 12. ECOLOGICAL INFORMATION

**Product Ecological Information:** --  
No ecological data available for this product.  
**Ingredient Ecological Information:** --  
No ecological data available for the ingredients of this product.

---

## 13. DISPOSAL CONSIDERATIONS

**EPA Waste ID Number:** None  
**Special Instructions (Disposal):** Work in an approved fume hood. Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.  
**Empty Containers:** Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.  
**NOTICE (Disposal):** These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

---

## 14. TRANSPORT INFORMATION

### **D.O.T.:**

**D.O.T. Proper Shipping Name:** Not Currently Regulated

--

**DOT Hazard Class:** NA

**DOT Subsidiary Risk:** NA

**DOT ID Number:** NA

**DOT Packing Group:** NA

### **I.C.A.O.:**

**I.C.A.O. Proper Shipping Name:** Not Currently Regulated

--

**ICAO Hazard Class:** NA

**ICAO Subsidiary Risk:** NA

**ICAO ID Number:** NA

**ICAO Packing Group:** NA

### **I.M.O.:**

**I.M.O. Proper Shipping Name:** Not Currently Regulated

--

**I.M.O. Hazard Class:** NA

**I.M.O. Subsidiary Risk:** NA

**I.M.O. ID Number:** NA

**I.M.O. Packing Group:** NA

**Additional Information:** There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

---

## 15. REGULATORY INFORMATION

### **U.S. Federal Regulations:**

**O.S.H.A.:** This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

### **E.P.A.:**

**S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370):** Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

**S.A.R.A. Title III Section 313 (40 CFR 372):** This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

**302 (EHS) TPQ (40 CFR 355):** Not applicable

**304 CERCLA RQ (40 CFR 302.4):** Not applicable

**304 EHS RQ (40 CFR 355):** Not applicable

**Clean Water Act (40 CFR 116.4):** Not applicable

**RCRA:** Contains no RCRA regulated substances.

**C.P.S.C.:** Not applicable

### **State Regulations:**

**California Prop. 65:** No Prop. 65 listed chemicals are present in this product.

**Identification of Prop. 65 Ingredient(s):** None

**California Perchlorate Rule CCR Title 22 Chap 33:**

**Trade Secret Registry:** Not applicable

### **National Inventories:**

**U.S. Inventory Status:** All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

**TSCA CAS Number:** Not applicable

---

## 16. OTHER INFORMATION

**Intended Use:** Phosphate determination

**References:** TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. In-house information. Technical Judgment. Outside Testing. NIOSH/OSHA Occupational Health

Guidelines for Chemical Hazards. Cincinnati: Department of Health and Human Services, 1981. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Vendor Information. Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Edition. Volume 2. New York: A Wiley-Interscience Publication, 1981.

**Revision Summary:** Updates in Section(s) 14,

---

**Legend:**

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

**USER RESPONSIBILITY:** Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

**THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.**

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Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

MSDS No: M00297

# MATERIAL SAFETY DATA SHEET

---

## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

**Product Name:** Phosphorus Molybdovanadate  
**Catalog Number:** 2525025

Hach Company  
P.O.Box 389  
Loveland, CO USA 80539  
(970) 669-3050

Emergency Telephone Numbers:  
(Medical and Transportation)  
(303) 623-5716 24 Hour Service  
(515)232-2533 8am - 4pm CST

**MSDS Number:** M00297  
**Chemical Name:** Not applicable  
**CAS No.:** Not applicable  
**Chemical Formula:** Not applicable  
**Chemical Family:** Not applicable  
**Hazard:** Harmful if inhaled. Carcinogen. Causes eye burns.  
**Date of MSDS Preparation:**  
**Day:** 20  
**Month:** April  
**Year:** 2010

---

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

### Ammonium Molybdate

**CAS No.:** 12054-85-2  
**TSCA CAS Number:** 12027-67-7  
**Percent Range:** 1.0 - 5.0  
**Percent Range Units:** weight / volume  
**LD50:** None reported.  
**LC50:** None reported.  
**TLV:** 5 mg/m<sup>3</sup> as Mo  
**PEL:** 5 mg/m<sup>3</sup> as Mo  
**Hazard:** Toxic. May cause irritation.

### Ammonium Metavanadate

**CAS No.:** 7803-55-6  
**TSCA CAS Number:** 7803-55-6  
**Percent Range:** < 1.0  
**Percent Range Units:** weight / volume  
**LD50:** Oral rat LD50 = 160 mg/kg; Oral rat LD50 = 58,100 µg/kg  
**LC50:** Inhalation rat LC50 = 7800 µg/m<sup>3</sup>/4H  
**TLV:** 0.05 mg/m<sup>3</sup> as V<sub>2</sub>O<sub>5</sub>  
**PEL:** Ceiling 0.05 mg/m<sup>3</sup> as V<sub>2</sub>O<sub>5</sub>  
**Hazard:** Toxic. May cause irritation.

### Demineralized Water

**CAS No.:** 7732-18-5  
**TSCA CAS Number:** 7732-18-5  
**Percent Range:** 50.0 - 60.0  
**Percent Range Units:** volume / volume  
**LD50:** None reported  
**LC50:** None reported  
**TLV:** Not established

**PEL:** Not established  
**Hazard:** No effects anticipated.

**Other component**

**CAS No.:** Not applicable  
**TSCA CAS Number:** Not applicable  
**Percent Range:** < 1.0  
**Percent Range Units:** weight / volume  
**LD50:** Not applicable  
**LC50:** Not applicable  
**TLV:** Not established  
**PEL:** Not established  
**Hazard:** Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

**Sulfuric Acid**

**CAS No.:** 7664-93-9  
**TSCA CAS Number:** 7664-93-9  
**Percent Range:** 35.0 - 45.0  
**Percent Range Units:** weight / volume  
**LD50:** Oral rat LD50 = 2140 mg/kg.  
**LC50:** Inhalation rat LC50 = 87 ppm/4 hr  
**TLV:** 1 mg/m<sup>3</sup> (TWA); 3 mg/m<sup>3</sup> (STEL)  
**PEL:** 1 mg/m<sup>3</sup>  
**Hazard:** Causes severe burns. Harmful if inhaled. Recognized carcinogen.

---

### 3. HAZARDS IDENTIFICATION

***Emergency Overview:***

**Appearance:** Clear, yellow liquid  
**Odor:** None  
CAUSES EYE BURNS HARMFUL IF INHALED CAUSES SKIN IRRITATION

***HMIS:***

**Health:** 3  
**Flammability:** 0  
**Reactivity:** 2  
**Protective Equipment:** X - See protective equipment, Section 8.

***NFPA:***

**Health:** 3  
**Flammability:** 0  
**Reactivity:** 2  
**Symbol:** Water Reactive

***Potential Health Effects:***

**Eye Contact:** Causes severe burns  
**Skin Contact:** Causes irritation  
**Skin Absorption:** None reported  
**Target Organs:** None reported  
**Ingestion:** Causes: severe burns May cause: loss of coordination copper deficiency gout May effect enzyme activity. Molybdenum compounds may cause loss of coordination, enzyme activity effects, copper deficiency and gout.  
**Target Organs:** None reported  
**Inhalation:** Causes: severe burns May cause: difficult breathing mouth soreness teeth erosion  
**Target Organs:** Lungs  
**Medical Conditions Aggravated:** Pre-existing: Eye conditions Skin conditions Respiratory conditions Gout  
**Chronic Effects:** Molybdenum poisoning signs include loss of appetite, listlessness and reduced growth rate. Excessive exposure to molybdenum compounds may cause gout and anemia. Chronic overexposure may cause erosion of the teeth enzyme activity effects copper deficiency chronic irritation or inflammation of the lungs cancer  
**Cancer / Reproductive Toxicity Information:**  
This product does NOT contain any OSHA listed carcinogens.

An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen  
Sulfuric Acid - The IARC evaluation was based on exposure to the mist or vapor of concentrated sulfuric acid generated during chemical processes.  
This product does NOT contain any NTP listed chemicals.

**Additional Cancer / Reproductive Toxicity Information:** Contains: an experimental teratogen. an experimental mutagen.

**Toxicologically Synergistic Products:** None reported

---

## 4. FIRST AID

**Eye Contact:** Immediately flush eyes with water for 15 minutes. Call physician.

**Skin Contact (First Aid):** Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.

**Ingestion (First Aid):** Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.

**Inhalation:** Remove to fresh air. Give artificial respiration if necessary. Call physician.

---

## 5. FIRE FIGHTING MEASURES

**Flammable Properties:** During a fire, corrosive and toxic gases may be generated by thermal decomposition. Not Flammable, but reacts with most metals to form flammable hydrogen gas.

**Flash Point:** Not applicable

**Method:** Not applicable

**Flammability Limits:**

**Lower Explosion Limits:** Not applicable

**Upper Explosion Limits:** Not applicable

**Autoignition Temperature:** Not applicable

**Hazardous Combustion Products:** Toxic fumes of: ammonia nitrogen oxides. sulfur oxides.

**Fire / Explosion Hazards:** May react violently with: reducers

**Static Discharge:** None reported.

**Mechanical Impact:** None reported

**Extinguishing Media:** Dry chemical. Do NOT use water.

**Fire Fighting Instruction:** As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

---

## 6. ACCIDENTAL RELEASE MEASURES

**Spill Response Notice:**

Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.

**Containment Technique:** Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment.

**Clean-up Technique:** Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Dilute with a large excess of water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.

**Evacuation Procedure:** Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.

**Special Instructions (for accidental release):** Mixture contains a component which is regulated as a water pollutant in the U. S. . Product is regulated as RCRA hazardous waste in the U.S.

**304 EHS RQ (40 CFR 355):** Sulfuric Acid - RQ 1000 lbs.

**D.O.T. Emergency Response Guide Number:** 154

---

## 7. HANDLING / STORAGE

**Handling:** Avoid contact with eyes skin clothing Do not breathe mist or vapors. Wash thoroughly after handling. Use with adequate ventilation. Maintain general industrial hygiene practices when using this product.

**Storage:** Store between 10° and 25°C. Protect from: light Store away from: oxidizers reducers metals  
**Flammability Class:** Not applicable

---

## 8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

**Engineering Controls:** Have an eyewash station nearby. Have a safety shower nearby. Use general ventilation to minimize exposure to mist, vapor or dust. Maintain general industrial hygiene practices when using this product.

**Personal Protective Equipment:**

**Eye Protection:** chemical splash goggles

**Skin Protection:** disposable latex gloves lab coat

**Inhalation Protection:** adequate ventilation

**Precautionary Measures:** Avoid contact with: eyes skin clothing Do not breathe: mist/vapor Wash thoroughly after handling. Use with adequate ventilation. Protect from: light

**TLV:** Not established

**PEL:** Not established

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## 9. PHYSICAL / CHEMICAL PROPERTIES

**Appearance:** Clear, yellow liquid

**Physical State:** Liquid

**Molecular Weight:** Not applicable

**Odor:** None

**pH:** < 0.5

**Vapor Pressure:** Not determined

**Vapor Density (air = 1):** Not determined

**Boiling Point:** 100°C (212°F)

**Melting Point:** Not determined

**Specific Gravity (water = 1):** 1.375

**Evaporation Rate (water = 1):** 0.06

**Volatile Organic Compounds Content:** Not applicable

**Partition Coefficient (n-octanol / water):** Not applicable

**Solubility:**

**Water:** Soluble

**Acid:** Soluble

**Other:** Not determined

**Metal Corrosivity:**

**Steel:** 11.273 in/yr

**Aluminum:** Not determined

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## 10. STABILITY / REACTIVITY

**Chemical Stability:** Stable when stored under proper conditions.

**Conditions to Avoid:** Extreme temperatures Heating to decomposition.

**Reactivity / Incompatibility:** May react violently in contact with: oxidizers reducers Incompatible with: metals

**Hazardous Decomposition:** Heating to decomposition releases toxic and/or corrosive fumes of: ammonia nitrogen oxides sulfur oxides Contact with metals may release flammable hydrogen gas.

**Hazardous Polymerization:** Will not occur.

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## 11. TOXICOLOGICAL INFORMATION

**Product Toxicological Data:**

**LD50:** None reported

**LC50:** None reported

**Dermal Toxicity Data:** None reported

**Skin and Eye Irritation Data:** This product is not corrosive to skin. Slight to well defined erythema. Absent to slight edema. (OECD Number 404, Acute Dermal Irritation/Corrosion)

**Mutation Data:** Ammonium Metavanadate: DNA damage - Human lymphocytes and ovary - 200 µmol/L; Mutation in somatic cells - hamster - lung - 5 µmol/L



**Reproductive Effects Data:** Intraperitoneal hamster TDLo = 2820 µg/kg - Musculoskeletal abnormalities;  
Intraperitoneal hamster TDLo = 11280 µg/kg - Post-implantation mortality  
**Ingredient Toxicological Data:** Sulfuric Acid: Oral rat LD50 = 2140 mg/kg, Inhalation rat LC50 = 347 ppm/1 hr;  
Ammonium Metavanadate: Oral rat LD50 = 58 mg/kg, Ammonium Molybdate (anhydrous): Oral rat LD50 = 333 mg/kg

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## 12. ECOLOGICAL INFORMATION

**Product Ecological Information:** --

No ecological data available for this product.

**Ingredient Ecological Information:** Sulfuric Acid: The 48-Hour TLm in flounder is 100-300 ppm.

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## 13. DISPOSAL CONSIDERATIONS

**EPA Waste ID Number:** D002

**Special Instructions (Disposal):** Work in an approved fume hood. Dilute to 3 to 5 times the volume with cold water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.

**Empty Containers:** Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.

**NOTICE (Disposal):** These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

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## 14. TRANSPORT INFORMATION

**D.O.T.:**

**D.O.T. Proper Shipping Name:** Corrosive Liquid, Acidic, Inorganic, N.O.S.

(<45% Sulfuric Acid in Solution)

**DOT Hazard Class:** 8

**DOT Subsidiary Risk:** NA

**DOT ID Number:** UN3264

**DOT Packing Group:** III

**I.C.A.O.:**

**I.C.A.O. Proper Shipping Name:** Corrosive Liquid, Acidic, Inorganic, N.O.S.

(<45% Sulfuric Acid in Solution)

**ICAO Hazard Class:** 8

**ICAO Subsidiary Risk:** NA

**ICAO ID Number:** UN3264

**ICAO Packing Group:** III

**I.M.O.:**

**I.M.O. Proper Shipping Name:** Corrosive Liquid, Acidic, Inorganic, N.O.S.

(<45% Sulfuric Acid in Solution)

**I.M.O. Hazard Class:** 8

**I.M.O. Subsidiary Risk:** NA

**I.M.O. ID Number:** UN3264

**I.M.O. Packing Group:** III

**Additional Information:** There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

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## 15. REGULATORY INFORMATION

**U.S. Federal Regulations:**

**O.S.H.A.:** This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

**E.P.A.:**

**S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370):** Immediate (Acute) Health Hazard Reactive  
Delayed (Chronic) Health Hazard

**S.A.R.A. Title III Section 313 (40 CFR 372):** This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.

Ammonium compounds; Sulfuric acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)

**302 (EHS) TPQ (40 CFR 355):** Sulfuric Acid 1000 lbs.

**304 CERCLA RQ (40 CFR 302.4):** Sulfuric Acid Ammonium vanadate 1000 lbs.

**304 EHS RQ (40 CFR 355):** Sulfuric Acid - RQ 1000 lbs.

**Clean Water Act (40 CFR 116.4):** Sulfuric acid - RQ 1000 lbs.

**RCRA:** Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.

**C.P.S.C.:** The label for this product bears the signal word "POISON" because the concentration of Sulfuric Acid in the product is greater than/equal to 10%.

**State Regulations:**

**California Prop. 65:** No Prop. 65 listed chemicals are present in this product.

**Identification of Prop. 65 Ingredient(s):** Not applicable

**California Perchlorate Rule CCR Title 22 Chap 33:**

**Trade Secret Registry:** Not applicable

**National Inventories:**

**U.S. Inventory Status:** All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

**TSCA CAS Number:** Not applicable

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## 16. OTHER INFORMATION

**Intended Use:** Indicator for phosphate

**References:** 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. In-house information. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987.

**Revision Summary:** Updates in Section(s) 15,

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**Legend:**

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

**USER RESPONSIBILITY:** Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

**THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.**

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## Appendix C – Procedure and Qualifications for Video Inspection

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## **PROCEDURE FOR VIDEO INSPECTION OF PROCESS SEWER LAGOON**

### **UNDERGROUND LINES**

#### 1.0 General

1.1 This specification includes the requirements and procedure for video inspection of straight run underground pipelines connected to the Process Sewer Lagoon.

1.2 The camera will be inserted into the pipeline and then be remotely positioned to view the interior surface of the pipeline throughout the underground portion of the line.

1.3 The crew will consist of a camera operator and a Qualified Inspector. The camera operator will control operation of the crawler and camera. The Qualified Inspector will view to video monitor and direct the camera operator.

1.4 The Qualified Inspector will hold current certifications as an API 570 Piping Inspector.

#### 2.0 Equipment Requirements

##### 2.1 Camera

2.1.1 The camera will have auto focus capability. In addition, the camera will be capable of remote operator override of camera aperture and/or illumination intensity.

2.1.2 The camera may be either forward facing (axial mount) or have pan and tilt capability depending on restrictions imposed by pipeline diameter and equipment availability.

##### 2.2 Lighting

2.2.1 The camera / crawler assembly will contain integral lighting for illumination of the pipeline interior.

##### 2.3 Crawler

2.3.1 The crawler will be capable of remotely controlled forward travel, and of traveling the entire underground length of the lines.

#### 3.0 Preparation

3.1 Pipelines will be flushed with raw water prior to video inspection.

#### 4.0 Data Collection

4.1 Data collected during the inspection will include:

4.1.1 Field notes taken by the Qualified Inspector.

4.1.2 A recording of the video output of the inspection camera.

4.2 The inspector will write a final inspection report. The inspection report, video log, and field notes will be archived in the DMAPS inspection database.

## 5.0 Field Procedures

### 5.1 General

5.1.1 Complete Safe Work Permit for inspection including:

5.1.1.1 Isolation of lines following Agrium Lock Out/Tag Out policy.

5.1.1.2 Entry into Process Sewer Lagoon per Agrium Confined Space Entry Policy.

5.1.1.3 Flush lines with raw water allowing flush water to flow back into the lagoon.

### 5.2 Inspection

5.2.1 Insert crawler/camera into discharge end of pipeline.

5.2.1.2 Ensure crawler lights and camera are working.

5.2.2 Start video recording.

5.2.3 Advance the crawler into the pipeline.

5.2.3.1 Slowly advance the crawler into the pipe line.

5.2.3.2 The Qualified Inspector will view the video monitor as the crawler advances.

5.2.3.2.1 The Qualified Inspector will make field notes of areas of concern during the inspection.

5.2.3.2.2 The Qualified Inspector will direct movement of the crawler/camera through voice communication with the camera operator. The camera will be halted at the request of the inspector for study of areas of special interest to the inspector.

5.2.4 Advance Crawler/Camera to end of pipeline.

5.2.4.1 Crawler/Camera will be slowly advanced until reaching block valves or plugs inserted inside the sump drywell, or until crawler is verified to have exited the underground portion of the line.

5.2.4.1.1 The Qualified Inspector will make field notes of areas of concern during the inspection.

5.2.4.1.2 The Qualified Inspector will direct movement of the crawler/camera through voice communication with the camera operator. The camera will be halted at the request of the inspector for study of areas of special interest to the inspector.

#### 5.2.5 Extract the Crawler/Camera

5.2.5.1 The crawler/camera will be removed from the pipeline either by driving the unit in reverse, or by hauling it by the umbilical.

#### 5.2.6 Halt video recording.

### 6.0 Data Evaluation

6.1 Field notes and video recording will be reviewed by the Qualified Inspector following the completion of the field data gathering.

6.2 The Qualified Inspector will write a summary report of findings and recommendations.

6.3 The Qualified Inspector will send the report to the production area superintendent and submit work requests for repairs the inspector determines are necessary.

6.4 The summary report, field notes, and video will be archived in the DMAPS inspection database.

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